PB-217 160

REPORT FOR CONSULTATION ON THE METROPOLITAN SAINT LOUIS INTERSTATE AIR QUALITY CONTROL REGION (MISSOURI-ILLINOIS)

National Air Pollution Control Administration
Washington, D. C.

December 1968

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 217 160

REPORT FOR CONSULTATION ON THE METROPOLITAN ST. LOUIS INTERSTATE AIR QUALITY CONTROL REGION (MISSOURI-ILLINOIS)

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
National Air Pollution Control Administration
December, 1968

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

BIBLIOGRAPHIC DATA SHEET	1. Report No. APTD-1210	2.	3. Recipient's Accession No.

4. Title and Subtitle
Report for Consultation on the Metropolitan St. Louis Interstate Air Quality Control Region (Missouri - Illinois)

5. Report Date
December 1968

6.

7. Author(s)

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
U. S. Department of Health, Education, and Welfare
Public Health Service
Consumer Protection and Environmental Health Service
National Air Pollution Control Administration

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address
Same

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstracts

The basic background information is presented for the consultation with state and local authorities prior to the designation of air quality control regions as stipulated in the Clean Air Act. Boundaries for the regions are proposed and the factors which are the basis for the proposed boundaries are discussed. Reports for consultation consider these factors: geography; population and economic activity; their prospective growth; probable direction of physical growth; the emission inventory and the location of sources; air quality and pollution transport analysis; regional planning; air pollution control; and governmental jurisdictions.

17. Key Words and Document Analysis. 17a. Descriptors

Air pollution
Regions
Geography
Humans
Industrial plants
Trends
Exhaust emissions
Inventories
Environmental surveys
Atmospheric diffusion
Planning
Abatement
Government

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group 13B

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Unlimited	UNCLASSIFIED	69
	20. Security Class (This Page) UNCLASSIFIED	22. Price

FORM NTIS-35 (10-70)

USCOMM-DC 40329-P71

CONTENTS

PREFACE.....3

INTRODUCTION.....4

EVALUATION OF ENGINEERING FACTORS.....12

EVALUATION OF URBAN FACTORS.....34

THE PROPOSED REGION.....45

DISCUSSION OF PROPOSAL.....45

APPENDIX A.....

APPENDIX B.....

PREFACE

The Secretary, Department of Health, Education, and Welfare, is directed by the Air Quality Act of 1967 to designate "air quality control regions" to provide a basis for the establishment of air quality standards and the implementation of air quality control programs. In addition to listing the major factors to be considered in the development of region boundaries, the Act stipulates that the designation of a region shall be preceded by consultation with appropriate State and local authorities.

The National Air Pollution Control Administration, DHEW, has conducted a study of the Metropolitan St. Louis urban area, the results of which are presented in this report. The Region* boundaries proposed in this report reflect consideration of all available and pertinent data; however, the boundaries remain subject to revision suggested by consultation with State and local authorities. Formal designation will be withheld pending the outcome of the meeting. This report is intended to serve as the starting point for the consultation.

The Administration is appreciative of assistance received either directly during the course of this study or indirectly during previous studies from the official air pollution agencies of the affected states and counties, the East-West Gateway Coordinating Council, and the Southwestern Illinois Metropolitan Area Planning Commission.

---

*For the purposes of this report, the word region, when capitalized, will refer to the Metropolitan St. Louis Interstate Air Quality Control Region. When not capitalized, unless otherwise noted, it will refer to air quality control regions in general.

Preceding page blank

INTRODUCTION

> "For the purpose of establishing ambient air quality standards pursuant to section 108, and for administrative and other purposes, the Secretary, after consultation with appropriate State and local authorities shall, to the extent feasible, within 18 months after the date of enactment of the Air Quality Act of 1967 designate air quality control regions based on jurisdictional boundaries, urban-industrial concentrations, and other factors including atmospheric areas necessary to provide adequate implementation of air quality standards. The Secretary may from time to time thereafter, as he determines necessary to protect the public health and welfare and after consultation with appropriate State and local authorities, revise the designation of such regions and designate additional air quality control regions. The Secretary shall immediately notify the Governor or Governors of the affected State or States of such designation."
>
> Section 107 (a), Air Quality Act of 1967

Air pollution, because of its direct relationship to people and their activities, is an urban problem. Urban sprawls often cover thousands of square miles; they quite often include parts of more than one state and almost always are made up of several counties and an even greater number of cities. Air pollution, therefore, also becomes a regional problem, and the collaboration of several governmental jurisdictions is prerequisite to the solution of the problem in any given area. Air quality control regions called for in the above-quoted section of the Air Quality Act of 1967 are meant to define the geographical extent of air pollution problems in different urban areas and the combination of jurisdictions that must contribute to the solution in each.

The regional approach set up by the Air Quality Act is illustrated in Figure 1. The approach involves a series of steps to be taken by Federal, State, and local governments, beginning with the designation of regions, the publication of air quality criteria, and the publication of information on available control techniques by the Federal Government. Following the completion of these three steps, the Governors of the States affected by a region must file with the Secretary within 90 days a letter of intent, indicating that the States will adopt within 180 days ambient air quality standards for the pollutants covered by the published criteria and control technology documents and adopt within an additional 180 days plans for the implementation, maintenance, and enforcement of those standards in the designated air quality control regions.

The new Federal legislation provides for a regional attack on air pollution and, at the same time, allows latitude in the form which regional efforts may take. While the Secretary reserves approval authority, the States involved in a designated region assume the responsibility for developing standards and an implementation plan which includes administrative procedures for abatement and control.

The basic objectives in the designation of an air quality control region is that it be self-contained, i.e. that the transfer of air pollution out of or into a region is minimized. This objective recognizes the fact that an air quality control region cannot be delineated in a way to make it completely independent with respect to the air pollution problem. Because air pollutants can be carried

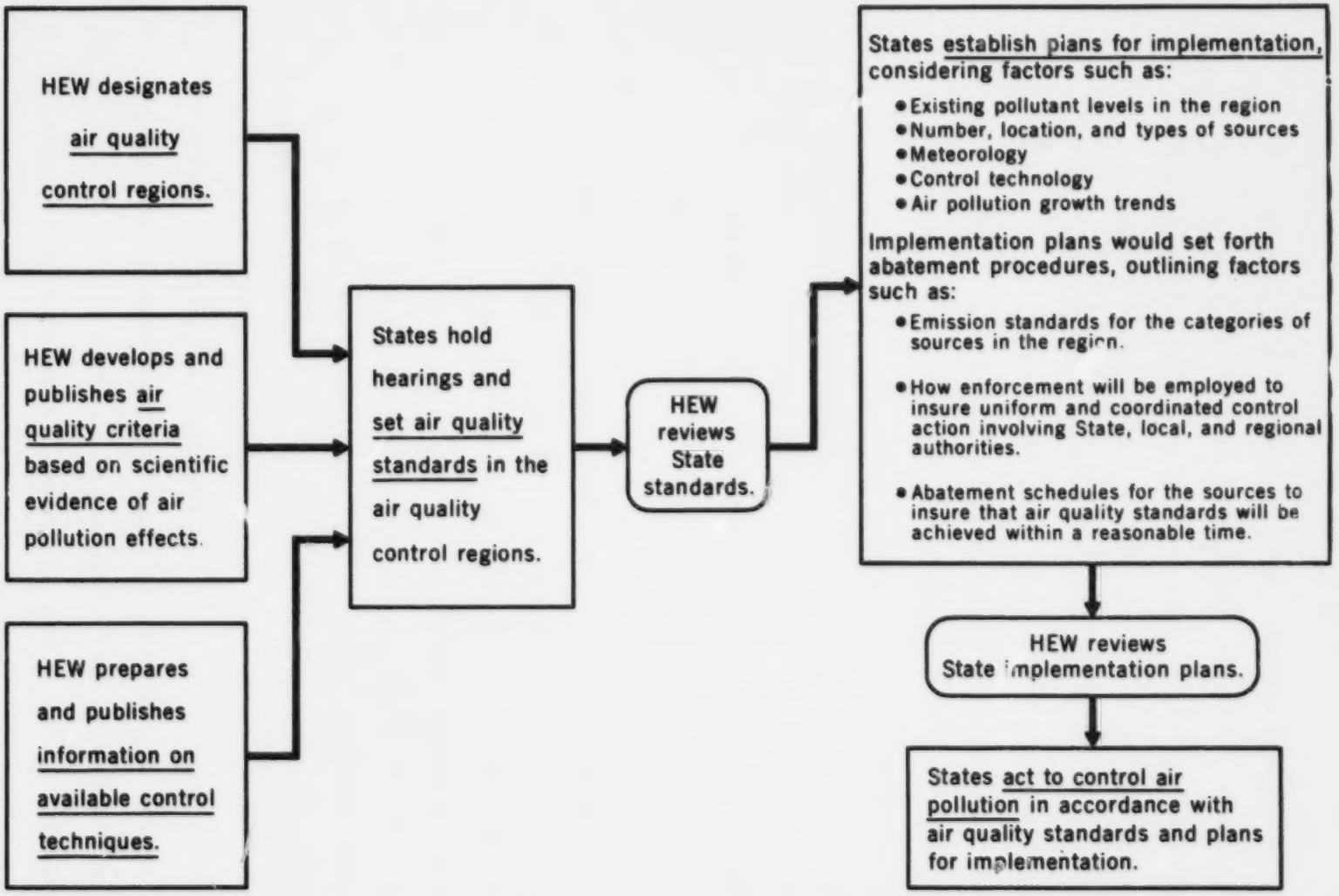

HEW designates air quality control regions.
HEW develops and publishes air quality criteria based on scientific evidence of air pollution effects.
HEW prepares and publishes information on available control techniques.
States hold hearings and set air quality standards in the air quality control regions.
HEW reviews State standards.
States establish plans for implementation, considering factors such as:
• Existing pollutant levels in the region
• Number, location, and types of sources
• Meteorology
• Control technology
• Air pollution growth trends
Implementation plans would set forth abatement procedures, outlining factors such as:
• Emission standards for the categories of sources in the region.
• How enforcement will be employed to insure uniform and coordinated control action involving State, local, and regional authorities.
• Abatement schedules for the sources to insure that air quality standards will be achieved within a reasonable time.
HEW reviews State implementation plans.
States act to control air pollution in accordance with air quality standards and plans for implementation.

Figure 1. Flow diagram for State action to control air pollution on a regional basis.

long distances, the air over a region can be subjected occasionally or even frequently to trace amounts of pollution from other cities and individual sources located outside its boundaries. Under specific and episodic conditions such contributions can even reach significant quantities. The problem of a boundary designation is further compounded in that urban areas generally do not end abruptly but are surrounded by activities that can contribute to the pollution of the urban area as well as be the recipients of its generated pollution. Consideration of all these possibilities would result in regions substantially larger than is practical or even necessary to get to the brunt of the problem. The primary question, therefore, becomes one of relative magnitude and frequency.

The boundaries of regions, however, should encompass areas that contain sources that add significantly to the pollution load of the air as well as the areas that are significantly and continuously arrected by it. For this purpose, the delineation of regional boundaries is based on evaluation of annual and seasonal air pollutant emissions and resultant ambient concentrations rather than those based on short-term and specific conditions.

The selection of regional boundaries should not be based solely on today's conditions and needs but, perhaps more importantly, should give consideration to future development and growth of the area. For this purpose, extensive consideration should be given to prescribed metropolitan plans as well as the forecasted growth. Such considerations should result in the designation of regions that will contain the sources and receptors of regional air pollution for a number of years

to come. This is not to say that the regional boundaries should remain stationary and unchanged. Periodic review of boundaries is desirable, and changes in the boundary should be considered if conditions warrant.

The delineation of region boundaries solely on the basis of source locations and distributional patterns of ambient air pollution would most likely result in regions that do not follow any existing governmental boundaries, are difficult to define, and, more importantly, extremely difficult if not impossible to administrate. It is for this purpose that existing jurisdictional entities are reviewed and wherein practical the boundary lines of a region should include that combination of whole jurisdictions that encompasses the problem area. There can be exceptions to this philosophy, however. The presence of overly large jurisdictions, marked topographical features (mountains), or notable differences in development within a given jurisdiction may, in some cases, make it desirable to include only portions of some jurisdictions.

A region, then, will represent a balance between the various objectives discussed so far to the extent that any two of them lead to different conclusions. The strength of some factors over others may lead to region boundaries which exclude some sources of pollution that might affect the air quality of part or all of the nearby region under certain conditions. Even though the impact of such sources would probably be minimal, the implementation plan required under the Air Quality Act for the region should provide a mechanism for the control of point sources that are located just beyond the region

boundary. Such a provision would be consistent with the basic objective of providing desirable air quality within an area being designated as an air quality control region.

Information on current industrial, commercial, and residential land use, transportation system, and population density is of direct value in that it illustrates generally the location of industry and people in an urban area. Furthermore, it is through an evaluation of estimated patterns of urbanization that the air quality control region can be designed to provide for future growth and expansion of the urban area.

Figure 2 summarizes the procedure used by the National Air Pollution Control Administration for designating air quality control regions.

A preliminary delineation of the region is developed by bringing together two essentially separate studies--the "Evaluation of Engineering Factors," and the "Evaluation of Urban Factors."

The study of "Engineering Factors" indicates the location of pollution sources and the geographic extent of serious pollutant concentrations in the ambient air. Pollution sources are located by an inventory of emissions from automobiles, industrial activities, space heating, waste disposal, and other pollution generators. Pollution concentrations in the ambient air are estimated from air quality sampling data and from a theoretical diffusion model. When it exists, air quality sampling data is more reliable than the theoretical diffusion model results since the data is directly recorded by pollution measuring

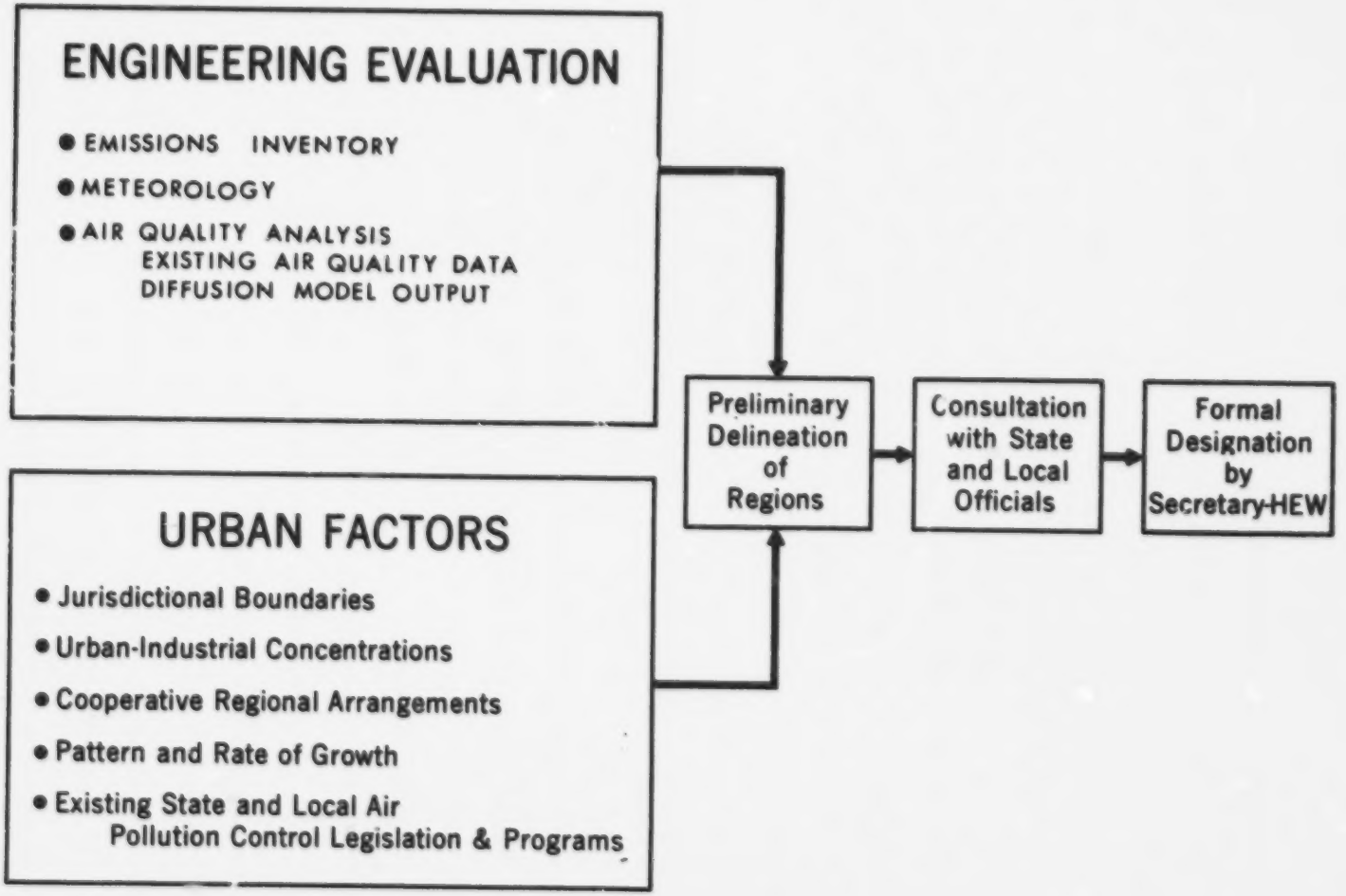

ENGINEERING EVALUATION
● EMISSIONS INVENTORY
● METEOROLOGY
● AIR QUALITY ANALYSIS
EXISTING AIR QUALITY DATA
DIFFUSION MODEL OUTPUT
URBAN FACTORS
● Jurisdictional Boundaries
● Urban-Industrial Concentrations
● Cooperative Regional Arrangements
● Pattern and Rate of Growth
● Existing State and Local Air Pollution Control Legislation & Programs
Preliminary Delineation of Regions
Consultation with State and Local Officials
Formal Designation by Secretary-HEW

Figure 2. Flow diagram for the designation of air quality control regions.

instruments. Unfortunately, in many cases extensive air quality sampling data is available for only one or two pollutants.

The study of "Urban Factors" encompasses all non-engineering considerations. It reviews existing governmental jurisdictions, current air pollution control programs, present concentrations of population and industry, and expected patterns of urban growth. Other non-engineering factors are discussed when they are relevant. As a whole, the study of urban factors indicates how large an air quality control region must be in order to encompass expected growth of pollution sources in the future. It also considers which group of governmental jurisdictions will most effectively administer a strong regional air quality control program.

The conclusions of the engineering study are combined with the results of the urban factors study to form the basis of an initial proposal for an air quality control region. As shown in Figure 2, the proposal is then submitted for consultation with State and local officials. After reviewing the suggestions raised during the consultation, the Secretary formally designates the region with a notice in the Federal Register and notifies the governors of the States affected by the designation.

The body of this report contains a proposal for the boundaries of the Metropolitan St. Louis Air Quality Control Region and supporting studies on engineering and urban factors. The report itself is intended to serve as the background document for the formal consultation with appropriate State and local authorities.

ENGINEERING EVALUATION

INTERSTATE AIR POLLUTION STUDY

In February 1962, simultaneous but independent requests were made by St. Louis City and the city of East St. Louis to the U.S. Public Health Service, Division of Air Pollution, for assistance in assessing and combating the air pollution problem in the St. Louis area. The result was the "Interstate Air Pollution Study." The study consisted of two phases. Phase I was conducted to assess the overall air pollution problem in the St. Louis area and to determine which activities should receive detailed analysis in Phase II. Numerous papers and brochures resulted from Phase II and the Phase II project report itself consisted of the following eight volumes:

I. Introduction
II. Air Pollutant Emission Inventory
III. Air Quality Measurements
IV. Odors--Results of Surveys
V. Meteorology and Topography
VI. Effects of Air Pollution
VII. Opinion Surveys and Air Quality Statistical Relationships.
VIII. Proposal for an Air Resources Management Program.

The area under study consisted of six counties plus St. Louis City. The counties were St. Louis, St. Charles, and Jefferson in Missouri, and Madison, St. Clair, and Monroe in Illinois.

Several volumes prepared during the Interstate Study were drawn upon in preparing this report. Some parts, however, have been updated in order to present current air pollution emission data and air quality data.

EMISSION INVENTORY

The emission inventory used in this study resulted from a rapid emission inventory of air pollutant sources in the St. Louis Metropolitan area.[1] The objectives of the inventory were to determine the total quantities of various air pollutants emitted using appropriate emission factors,[2] to estimate the geographical and seasonal variation in air pollutant emissions, and to determine any overall change in emissions from those determined during the Insterstate Study, 1963. Accordingly, the study area was divided into a grid coordinate system and the emission quantities were reported in terms of tons of pollutant per grid on an average summer day, average winter day, and average annual day.

The pollutants considered in this survey are sulfur oxides,* particulates and carbon monoxide. The patterns of emissions and concentrations of these three pollutants provide some measure of the general geographical extent of the overall problem. Sulfur oxides pollution levels illustrate the impact of fuel burning activities at stationary sources. Levels of carbon monoxide provide the best indication of the impact of gasoline-powered motor vehicles on the regional air pollution pattern. The particulate emission densities indicate primarily the extent of industrial, power, incineration, and heating sources.

Data presented herein are representative of 1967 and were gathered mainly by state and local agencies. The area covered by the

*Sulfur dioxide constitutes the majority of sulfur oxide pollution. In this evaluation, sulfur oxide emissions and concentrations are assumed to be composed entirely of sulfur dioxide.

emission inventory consists of St. Louis City and the counties of St. Louis, St. Charles, Franklin, and Jefferson in Missouri, and the counties of Madison, St. Clair, and Monroe in Illinois. (Franklin County was not included in the Interstate Study.)

For the purposes of this survey, the study area was divided into two separate grid systems, both based on latitude and longitude--one for the reporting of SO_x and particulates and other for the reporting of CO. Four grid sizes of 2, 4, 8, and 16 minutes were utilized for delineating emissions of SO_x and particulates and one grid size of 15 minutes was used for emissions of CO. The smaller grids were used on the densest areas of population and industry. Figures A-1 and A-2 in Appendix A illustrate the grid system used for SOx and particulates and for CO respectively. Pollutant emissions are considered negligible in those areas outside of the grid patterns. Tables A-1 through A-3 in Appendix A give the emission inventory, by grid, for average annual, summer, and winter days. Figure 3 illustrates the location of major point sources. Figures 4 through 6 show winter emission densities of the three pollutants. Concentrations of point sources and pollutant emissions are highest in the St. Louis-East St. Louis area and in the north-west corner of Madison County in the vicinity of Alton.

Table 1 presents a summary of the three pollutants by source category. The 1967 emissions inventory was essentially an updating of the 1963 study.[3] Major differences can be explained in terms of new or controlled sources, or sources which were omitted in the Interstate Study.

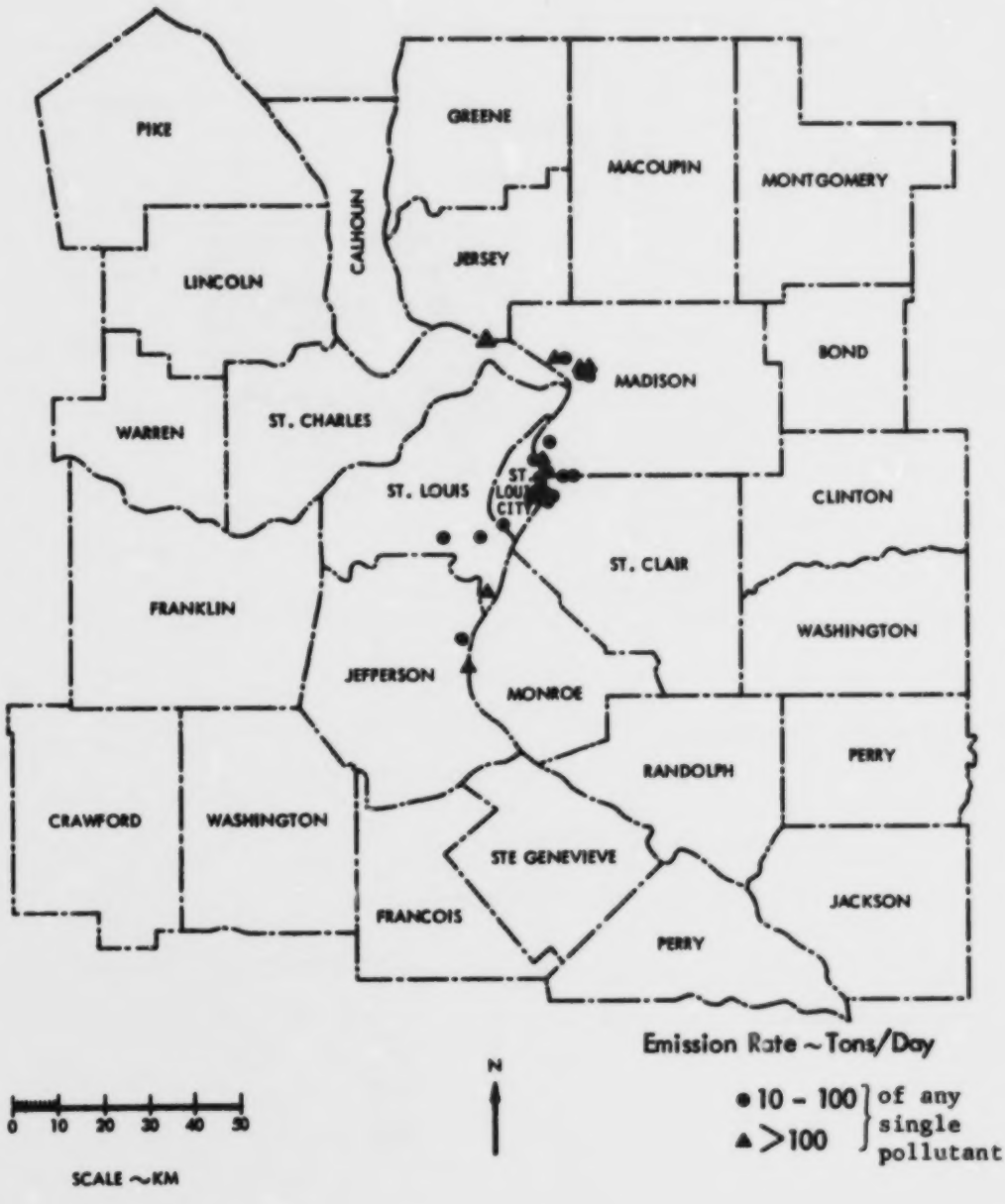


Figure 3. Major Point Sources

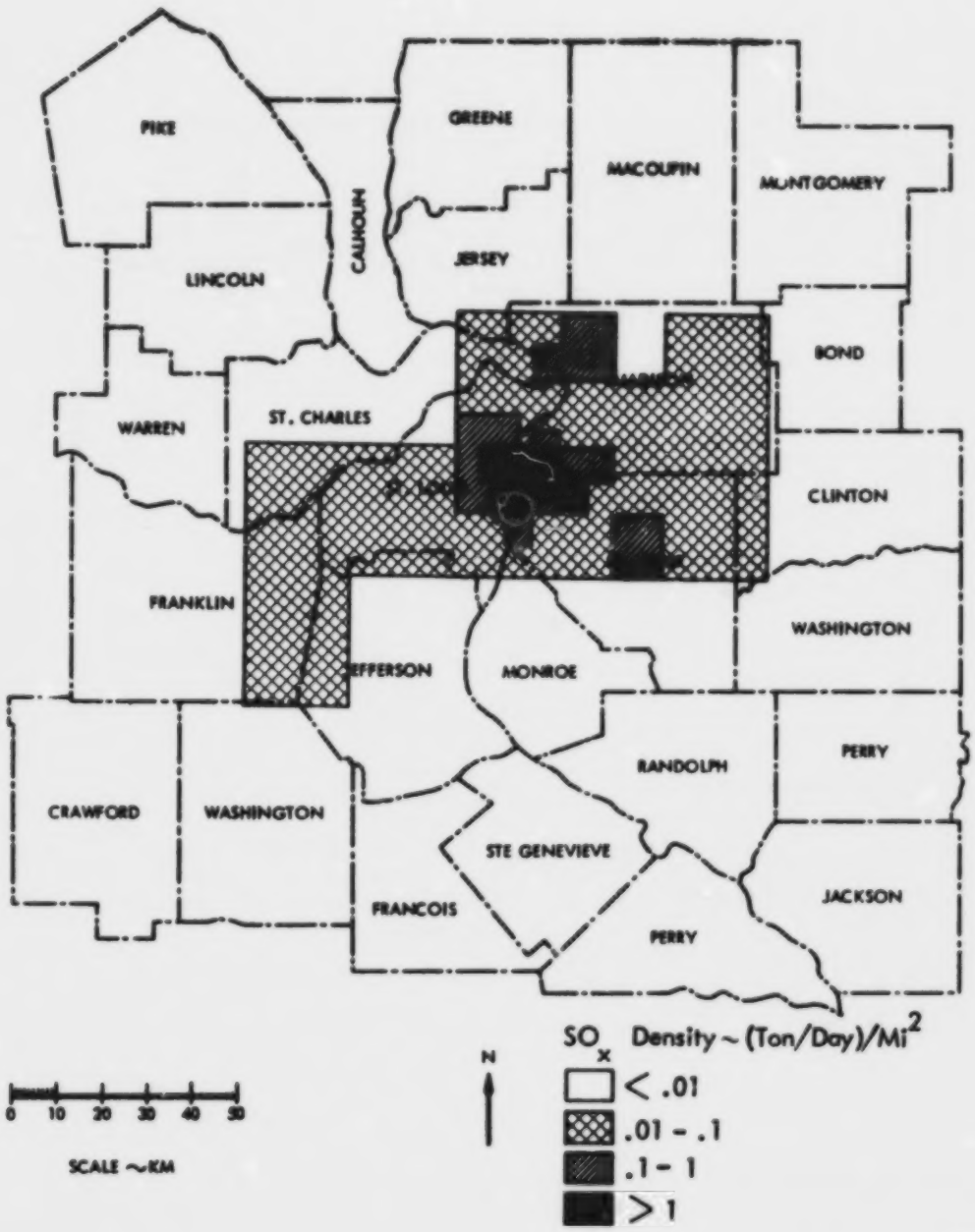


Figure 4. Sulfur Oxides Emission Density by Study Area Zone, Winter Average

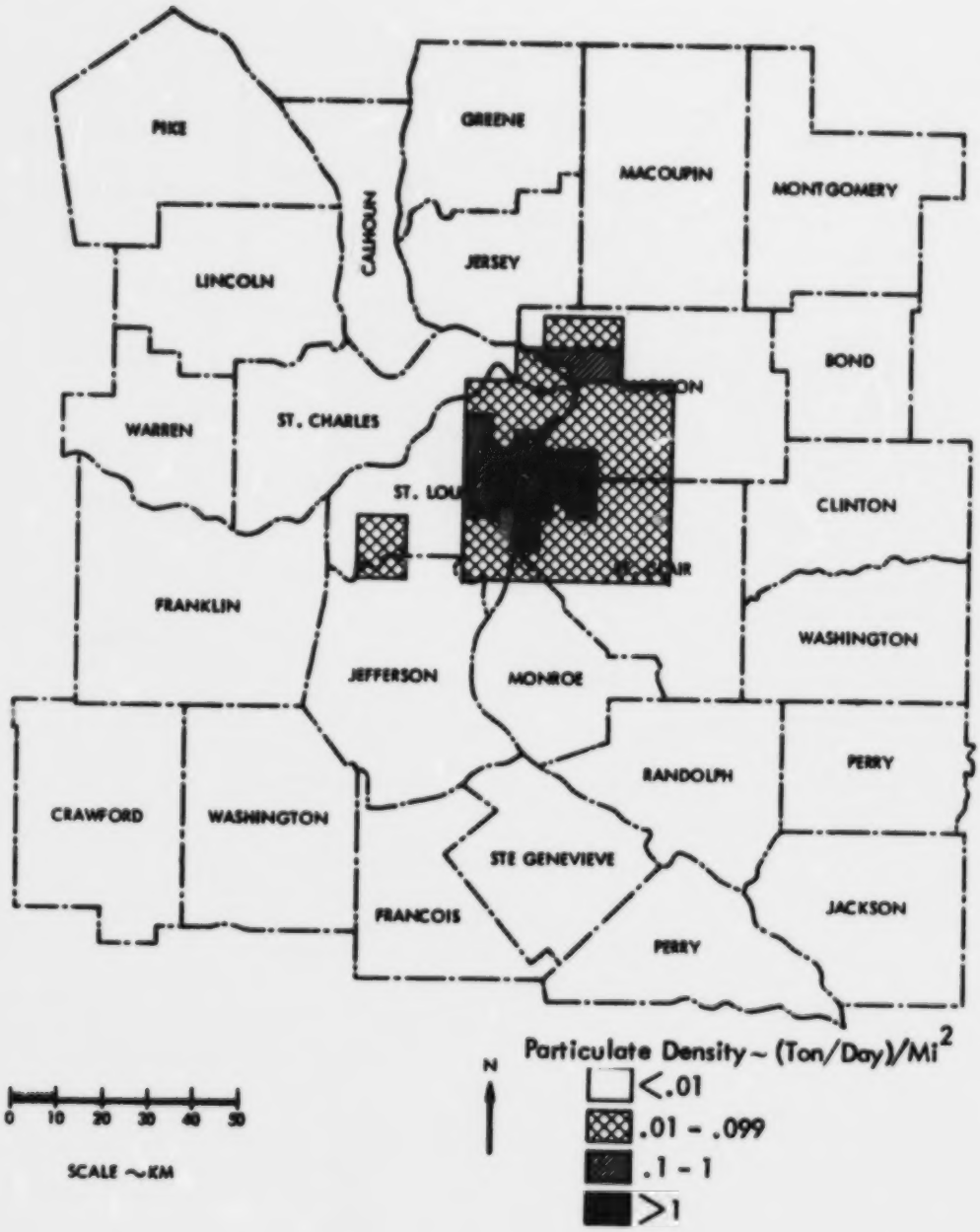


Figure 5. Particulate Emission Density by Study Area Zone, Winter Average

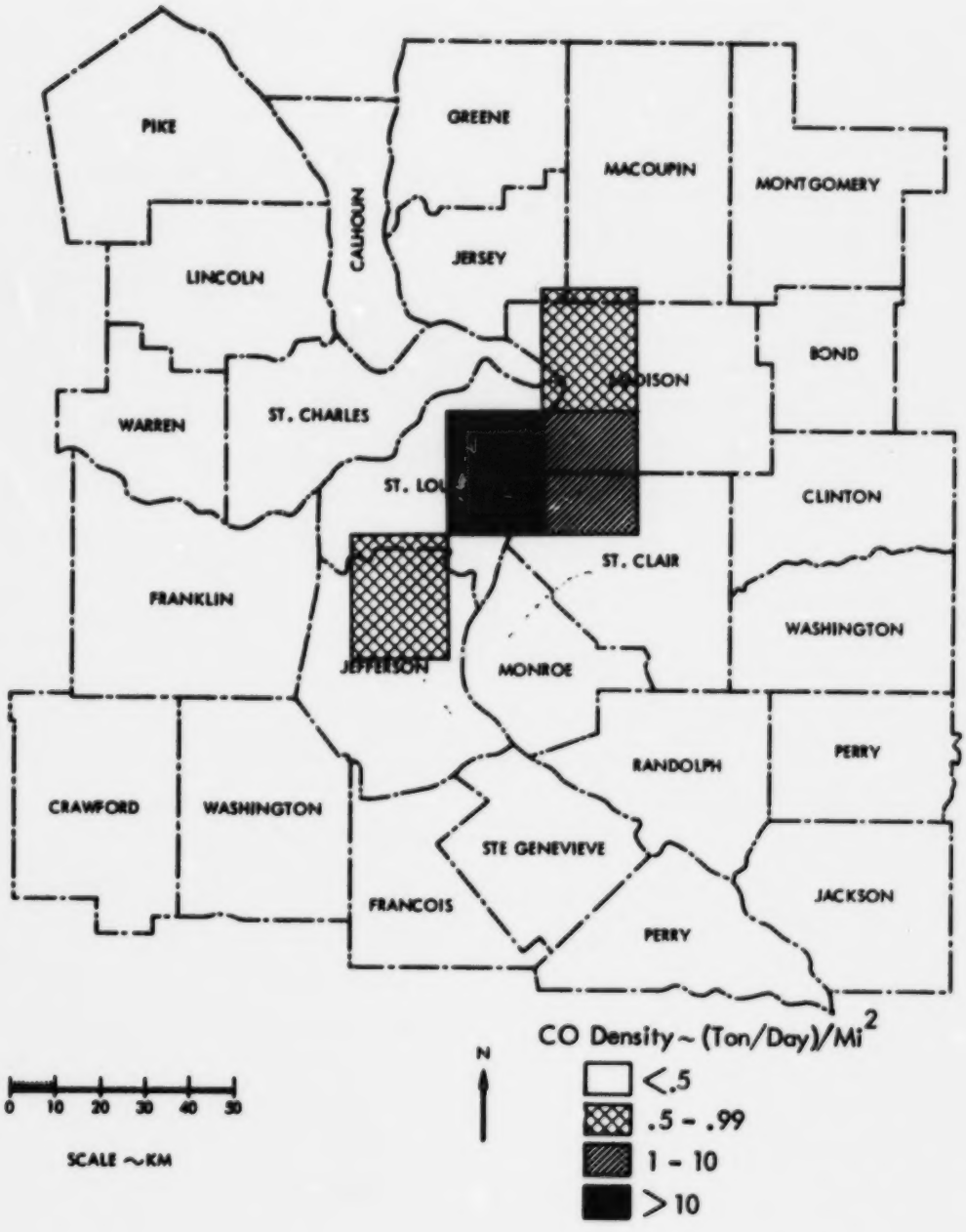


Figure 6. Carbon Monoxide Emission Density by Study Area Zone, Winter Average

TABLE I. SUMMARY OF AIR POLLUTANT EMISSIONS IN THE ST. LOUIS AIR POLLUTION STUDY AREA, 1967 (TONS/YEAR)

Source Category	Sulfur Oxides 1967	Particulates 1967	Carbon Monoxide 1967
Transportation	5,100	8,800	1,271,000
Road Vehicles	4,100	5,400	1,245,000
Other	1,000	3,400	26,000
Combustion of Fuels (stationary sources)	538,800	123,210	28,197
Industry	110,600	46,300	3,258
Steam-Elec. Util.	368,592	50,411	1,402
Residential	49,201	22,058	20,744
Other	10,385	4,441	2,793
Refuse Disposal	634	4,918	16,500
Incineration	306	2,294	2,052
Open Burning	328	2,624	14,500
Industrial Process Emissions	117,781	38,700	327,600
TOTALS*	662,300	175,600	1,643,300

*Rounded to nearest 100 tons/year

The increase in emissions under transportation sources, especially carbon monoxide, is due to a growth in motor vehicle activity. Increase in particulate and sulfur oxides emissions since 1963 by steam-electric utilities is due primarily to the addition of a major power plant which was not on line in 1963.

AIR QUALITY ANALYSIS

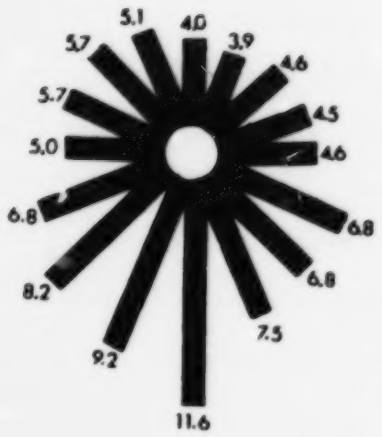
The geographical distribution of pollutant sources illustrates the core of the problem area. It does not, however, elucidate the extent of the influence of pollution sources on the people and property located outside the highly urbanized portion of the St. Louis metropolitan area. A study of air quality levels known or estimated to occur is useful in determining the area affected by the pollution sources and thus subject to inclusion in the air quality control region. Such analysis can be based directly on air sampling data in those instances where the sampling program covers a large enough area and has been in existence long enough to provide reliable patterns of air quality throughout the region under study.

The Interstate Air Pollution Study provided a wealth of air quality data from the core area for two of the three pollutants considered in this report. Contour lines based on sampling station data were presented for both SO_2 and particulates.[5]

Carbon monoxide levels, however, are more difficult to analyze and predict. Motor vehicles are the prime emittors of CO; consequently, the concentrations of both emissions and air quality are closely related to the traffic patterns. The CAMP station in St. Louis City

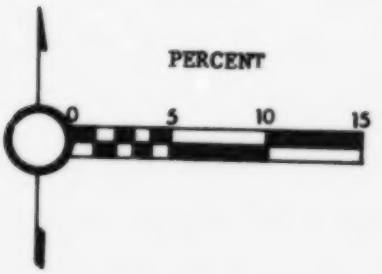
was the only CO sampling station during the Interstate Study. CO levels in the general metropolitan area can hardly be predicted from the CO concentration values at only one station. It becomes necessary, therefore, to develop estimates of relative air quality. Diffusion modeling is a technique by which such estimates can be made based on the location and quantity of pollutant emissions and on meteorological conditions. The influence of topography on ambient air quality levels is reflected in the results of the model, but only to the extent that it influences meteorological conditions. The diffusion model used in this study is treated in detail in Appendix B.

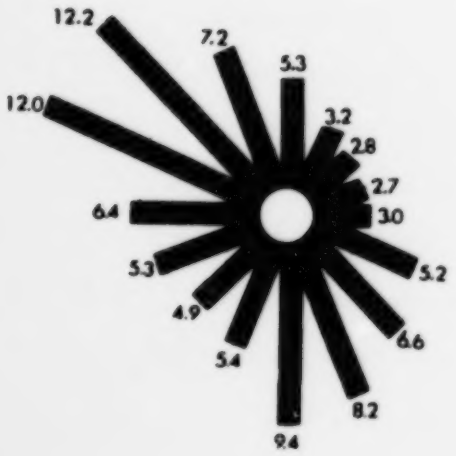
The diffusion model was applied for SO_x and particulates as well as for CO for average annual, winter, and summer days. Figure 7 and Table B-1 show the meteorological data required to apply the model. Figure 7 shows the per cent frequency of occurence of wind direction from 1951 through 1960 at Lambert Field, 12 miles from downtown St. Louis. The wind speed and direction data used in the diffusion model were considered representative of the prevailing wind patterns throughout the general St. Louis area. Since the Martin-Tikvart model[4] used in this study attempts to show long-term rather than episodic air-quality conditions, only average emissions and long-term average meteorology are considered. If episodic data (i.e., data with a very low frequency of occurence) were used to aid in delineating a region boundary, the region would be unnecessarily large. Even the "smaller" region defined on the basis of mean conditions would



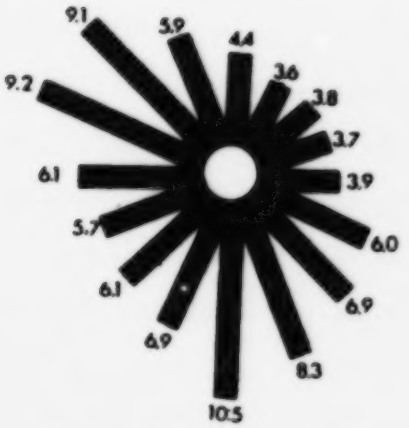
SUMMER
(June, July, August)

Figure 7. Percent frequency of wind direction for various averaging times. based on 1951-1960 data.





WINTER
(December, January February)



ANNUAL

undoubtedly encompass the area of maximum concentration upon which a reduction plan is to be developed.

The mixing depths for the time periods are an average of the mean morning and afternoon values, as shown in Table B-1 in Appendix B; these data were obtained from tabulations prepared by the National Weather Records Center (ESSA). Combined with wind data, these data are used in the diffusion model to assess the spatial distribution of concentrations of suspended particulates, sulfur oxides, and carbon monoxide.

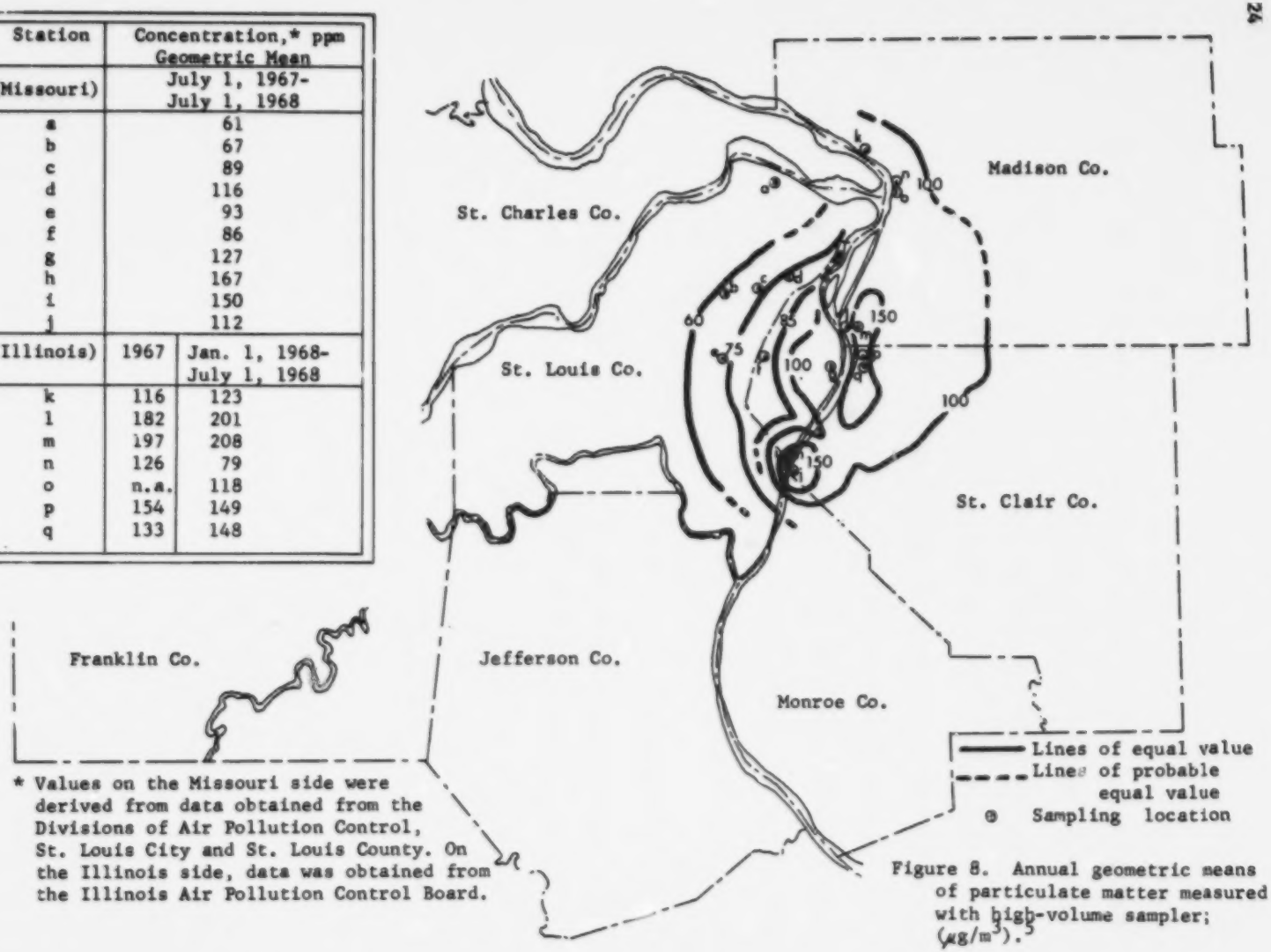
Suspended Particulates

In previous reports proposing air quality control regions for New York City, Chicago, and Denver, the area within the assumed background level contour line for suspended particulates was considered for inclusion in the region. Background is assumed to be approximately 40 $\mu g/m^3$ in the area surrounding St. Louis. The area within this contour, then, is considered the area most affected by emissions in the St. Louis Metropolitan Area.

Figure 8 shows the contour lines for suspended particulates based on sampling results from July 1, 1963, to July 1, 1964. The lines are the same as those published in the Interstate Study, Volumes III and VIII.* Incorporated on the same figure are values of sampling stations for the period July 1, 1967, to July 1, 1968, in Missouri and for the

*Isopleths were redrawn on a map of smaller scale to show the relationship of the contour lines to the surrounding counties.

Station	Concentration,* ppm Geometric Mean	
(Missouri)	July 1, 1967-July 1, 1968	
a	61	
b	67	
c	89	
d	116	
e	93	
f	86	
g	127	
h	167	
i	150	
j	112	
(Illinois)	1967	Jan. 1, 1968-July 1, 1968
k	116	123
l	182	201
m	197	208
n	126	79
o	n.a.	118
p	154	149
q	133	148



* Values on the Missouri side were derived from data obtained from the Divisions of Air Pollution Control, St. Louis City and St. Louis County. On the Illinois side, data was obtained from the Illinois Air Pollution Control Board.

Figure 8. Annual geometric means of particulate matter measured with high-volume sampler; ($\mu g/m^3$).[5]

period Jan. 1, 1967, to July 1, 1968, in Illinois. The recent emission inventory showed a slight increase in particulate emissions from 1963 to 1967. This fact, coupled with the 1967-1968 sampling data plotted on Figure 8, indicates a slight increase in suspended particulate levels from 1963. Assuming, however, that this trend is very gradual and that the change from 1963-1968 is insignificant as far as the location of the background level (40 $\mu g/m^3$) contour line, Figure 8 might be used to assess the spatial distribution of suspended particulate concentrations.

Sampling stations for the Interstate Study were mainly situated towards the center of the urban complex, so there were not enough points to draw a contour line for 40 $\mu g/m^3$. By extrapolation, however, one can see that this isopleth would probably pass through the following counties: St. Charles, St. Louis, and Jefferson in Missouri, and Monroe, St. Clair, Madison, Jersey, and Macoupin in Illinois.

Theoretical suspended particulate contour lines were produced by the diffusion model. The results are shown in Figure 9. The contours of Figure 9 were produced independent of sampling data and were based solely on emissions and meteorology. The 40 $\mu g/m^3$ isopleth crosses the same jurisdictions as were mentioned above.

Sulfur Oxides

Figure 10 is a reproduction of SO_2 contour lines from the Interstate Study.[5] The isopleths are based on 24-hour SO_2 samples of geometric means for winter, 1964-65. On the basis that SO_X

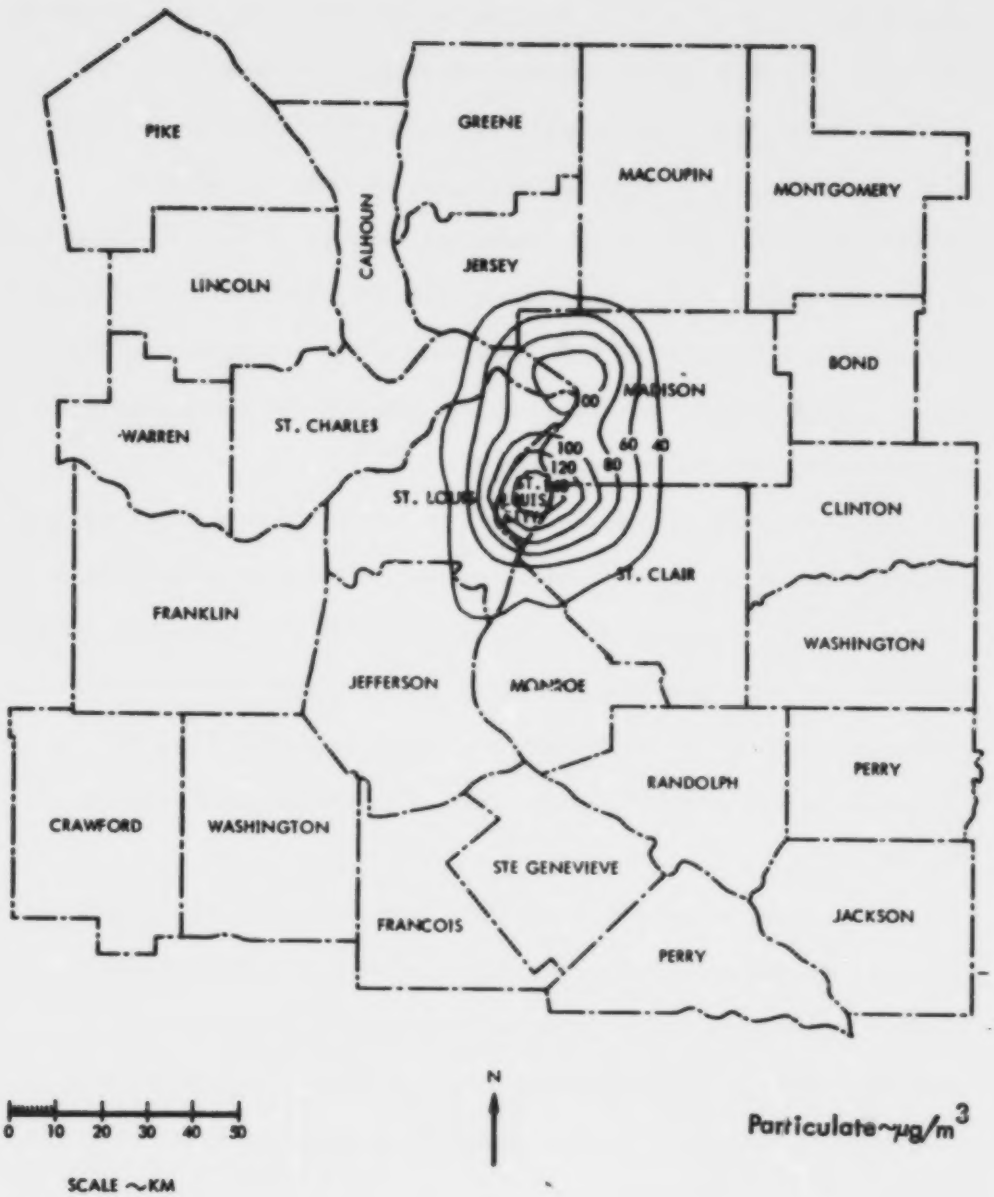


Figure 9. Theoretical Particulate Concentration - Annual Average

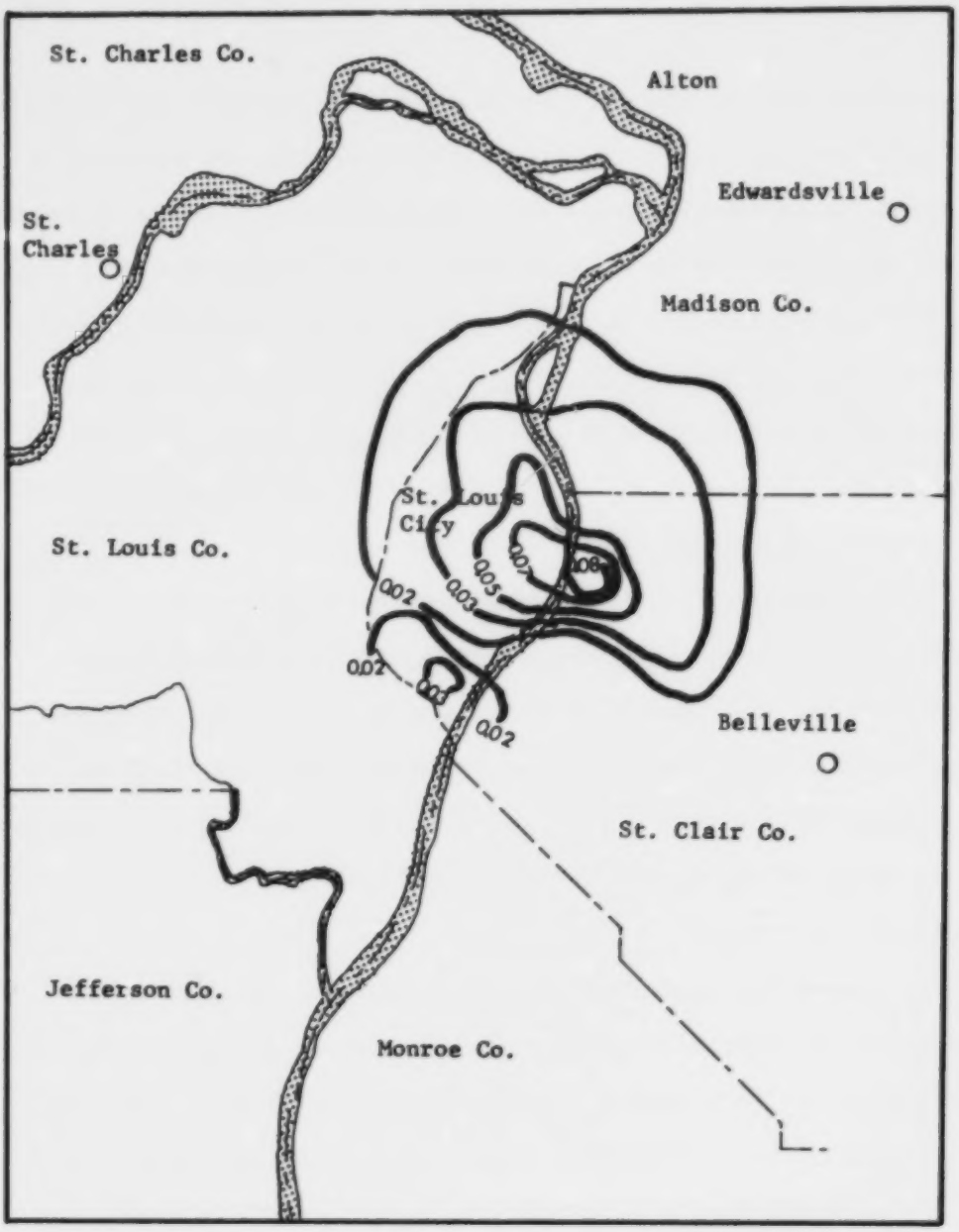


Figure 10. 24-hour sulfur dioxide geometric means (ppm)[5] for 40-station network during winter of 1964-65.

emissions have not changed significantly in the core of the St. Louis Study area, the contours present a good picture of the situation in the St. Louis-East St. Louis area. The map is less adequate, however, for aid in delineating a region boundary, since there are no concentration contours in the Alton area. As was pointed out previously, the increase in SO_X emissions in the whole study area in 1967 is due primarily to a power plant in St. Charles County which was not on line in 1963-64. Also, a cluster of important SO_X point sources are located in or near Alton.

The theoretical diffusion model iso-intensity contours of SO_X give a better coverage of the general study area. Figure 11 shows contours based on average winter meteorology and winter emissions for 1967. A three-hour half-life was incorporated into the model to allow for atmospheric reaction of SO_X into other sulfur compounds. The values of the contour lines were adjusted* to conform with air quality measurements.

A concentration of 0.01 ppm SO_X has been used as a guide in previous air quality control region proposals as an appropriate level for outlining general problem areas. The adjusted theoretical 0.01 ppm isopleth encompasses or extends into the following jurisdictions: St. Louis City and the counties of St. Charles, St. Louis, and Jefferson in Missouri, Jersey, Madison, St. Clair, and Monroe in Illinois.

*Adjustment was done as follows: a diffusion model contour line which corresponded closely in geographical extent to the 0.02 ppm closed contour of Figure 10 was assigned a value of 0.02 ppm. Remaining contours were adjusted in the same proportion.

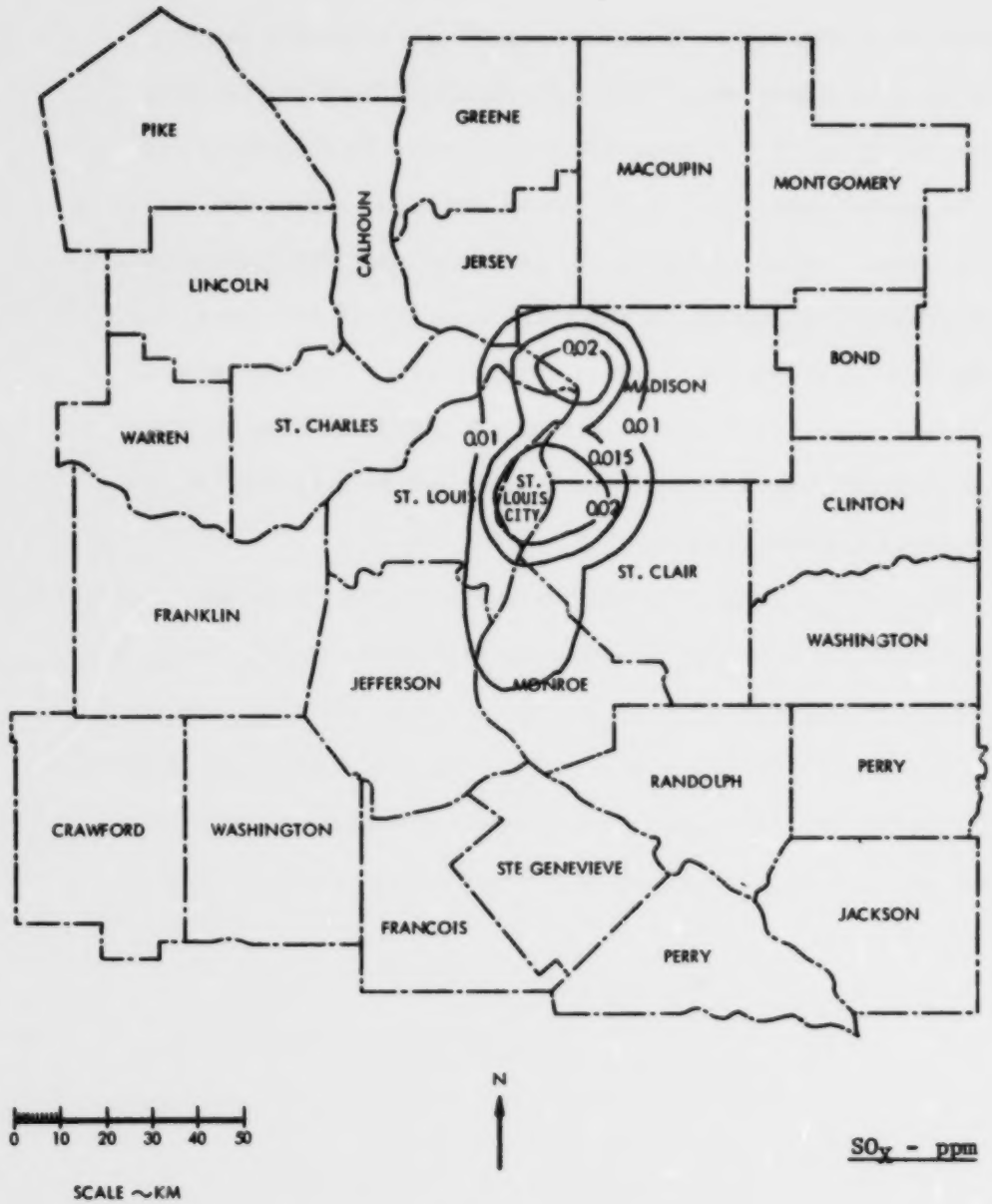


Figure 11. Adjusted <u>theoretical</u> SO_X concentration, winter average.

Carbon Monoxide

Contour lines showing theoretical relative CO concentrations are presented in Figure 12. Though winter CO emissions are slightly greater than summer emissions, meteorological factors (see wind roses in Figure 7) are responsible for higher CO concentrations in the summer months in the St. Louis and Alton areas. The diffusion model output, shown in Figure 12, indicates that the highest relative CO concentrations appear in the Alton area and in St. Louis City where traffic volume is greatest. High CO concentrations around Alton are caused by the transport of the pollutant from St. Louis by predominate south to south-west winds and by a cluster of point sources in and around Alton.

Figure 13* shows main traffic arteries (highways) in the St. Louis Study Area.[6] Highways may be viewed as line sources of CO emissions. The highest concentrations of traffic arteries are in St. Louis City and County, Madison and St. Clair Counties. Jefferson, Franklin, St. Charles, Monroe, Jersey, and Macoupin Counties are much less affected by CO emissions from high traffic volumes.

* Redrawn and produced in this report by permission of the East-West Gateway Coordinating Council.

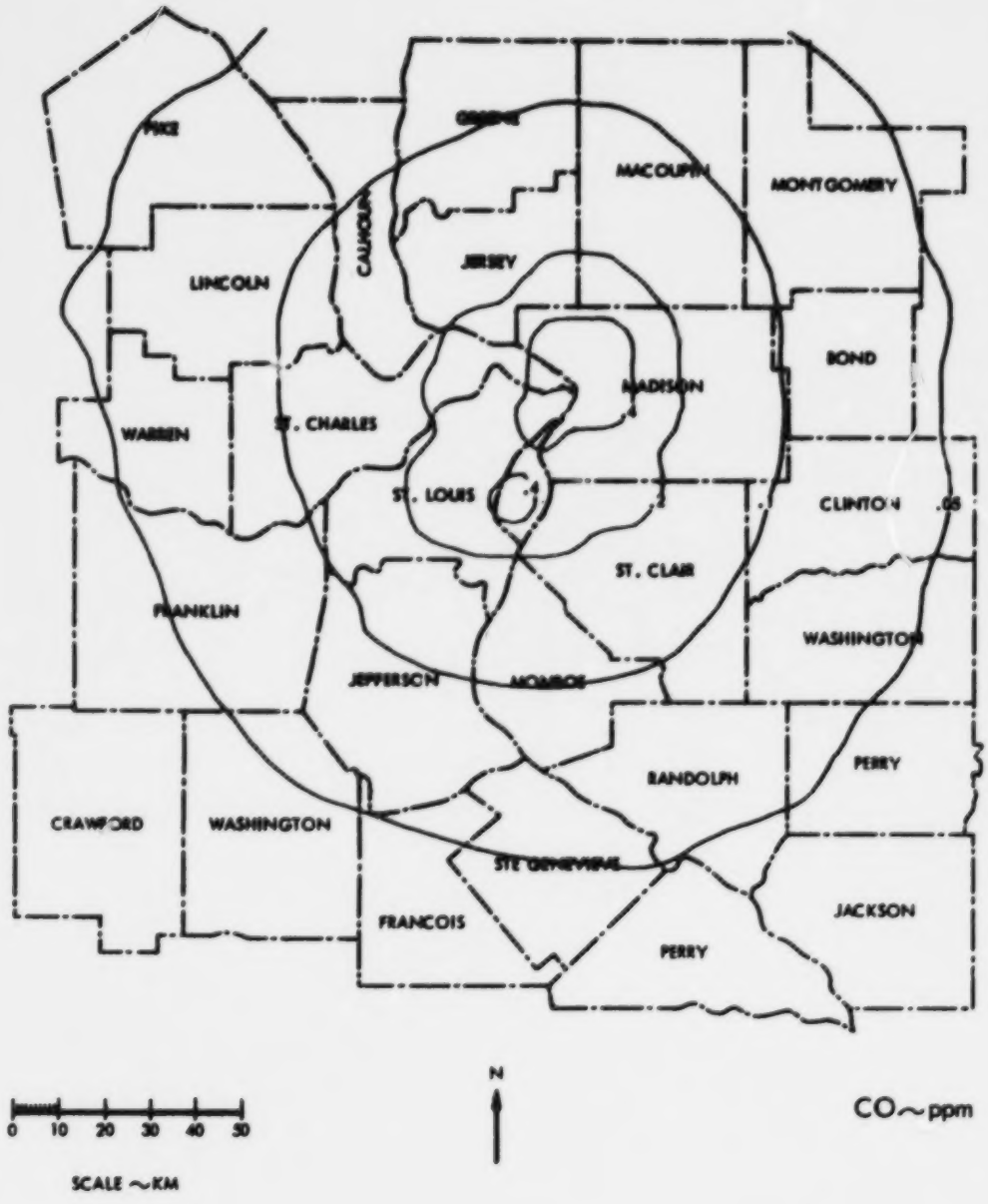


Figure 12. Theoretical CO Concentration - Summer Average

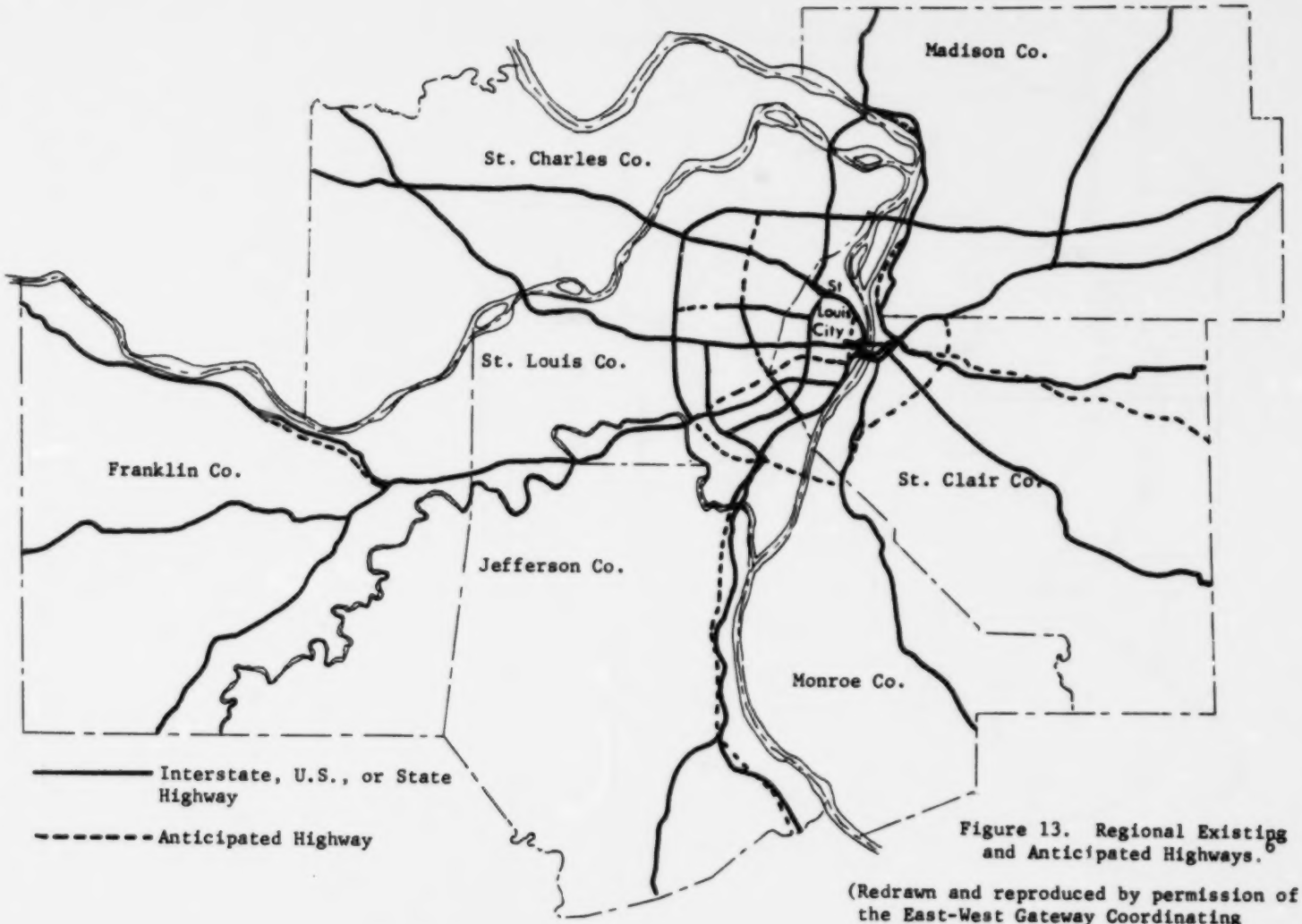


Figure 13. Regional Existing and Anticipated Highways.[6]

(Redrawn and reproduced by permission of the East-West Gateway Coordinating Council)

REFERENCES

1. "Rapid Survey Technique for Estimating Community Air Pollution Emissions," PHS, Publication No. 999-AP-29, Environmental Health Series, USDHEW, NCAPC, Cincinnati, Ohio, October, 1966.

2. "A Compilation of Air Pollution Emission Factors," Duprey, R.L., USDHEW, PHS, BDPEC, NCAPC, Durham, North Carolina, 1968.

3. "Interstate Air Pollution Study," Phase II Project Report, Vol. II, Air Pollutant Emission Inventory, R. Venezia and G. Ozolins, USDHEW, PHS, NCAPC, Cincinnati, Ohio, Revised December, 1966.

4. "General Atmospheric Diffusion Model for Estimating the Effects on Air Quality of One or More Sources," Martin, D.O., and Tikvart, J.A., Paper No. 68-148, 61 Annual Meeting, APCA, St. Paul, Minnesota, June, 1968.

5. "Interstate Air Pollution Study," Phase II Project Report, Volume III, Air Quality Measurements, R. Venezia and G. Ozolins, USDHEW, PHS, NCAPC, Cincinnati, Ohio, December, 1966.

6. "Population Projections for the East-West Gateway Study Area," prepared by Hubert Williams, East-West Gateway Coordinating Council, September 3, 1968.

EVALUATION OF URBAN FACTORS

In designing a workable air quality control region, factors other than pollutant emissions and air quality levels must be considered. Present population and population growth patterns are important, since the region should encompass most of the people in the vicinity of the urban complex. The pattern of industry and projected industrial development is equally important. Existing governmental structures must also receive consideration since the Air Quality Act specifically notes that regions must be based on jurisdictional boundaries. Only a combination of several jurisdictions or parts thereof can provide a genuine regional approach to the overall problem. Coordinated efforts such as councils' of governments and planning agencies should receive consideration. Consideration is also given to existing local air pollution control agencies in the St. Louis Area.

Population

Figure 14* shows the 1960 and the projected 1990 pattern of urbanization in the metropolitan St. Louis area.[1] The 1960 general urbanized area centers on St. Louis City, East St. Louis, and St. Louis County with arms extending into St. Charles, Madison, and St. Clair Counties. According to Figure 14, urbanization in Franklin,

*Redrawn and produced in this report by permission of the East-West Gateway Coordinating Council.

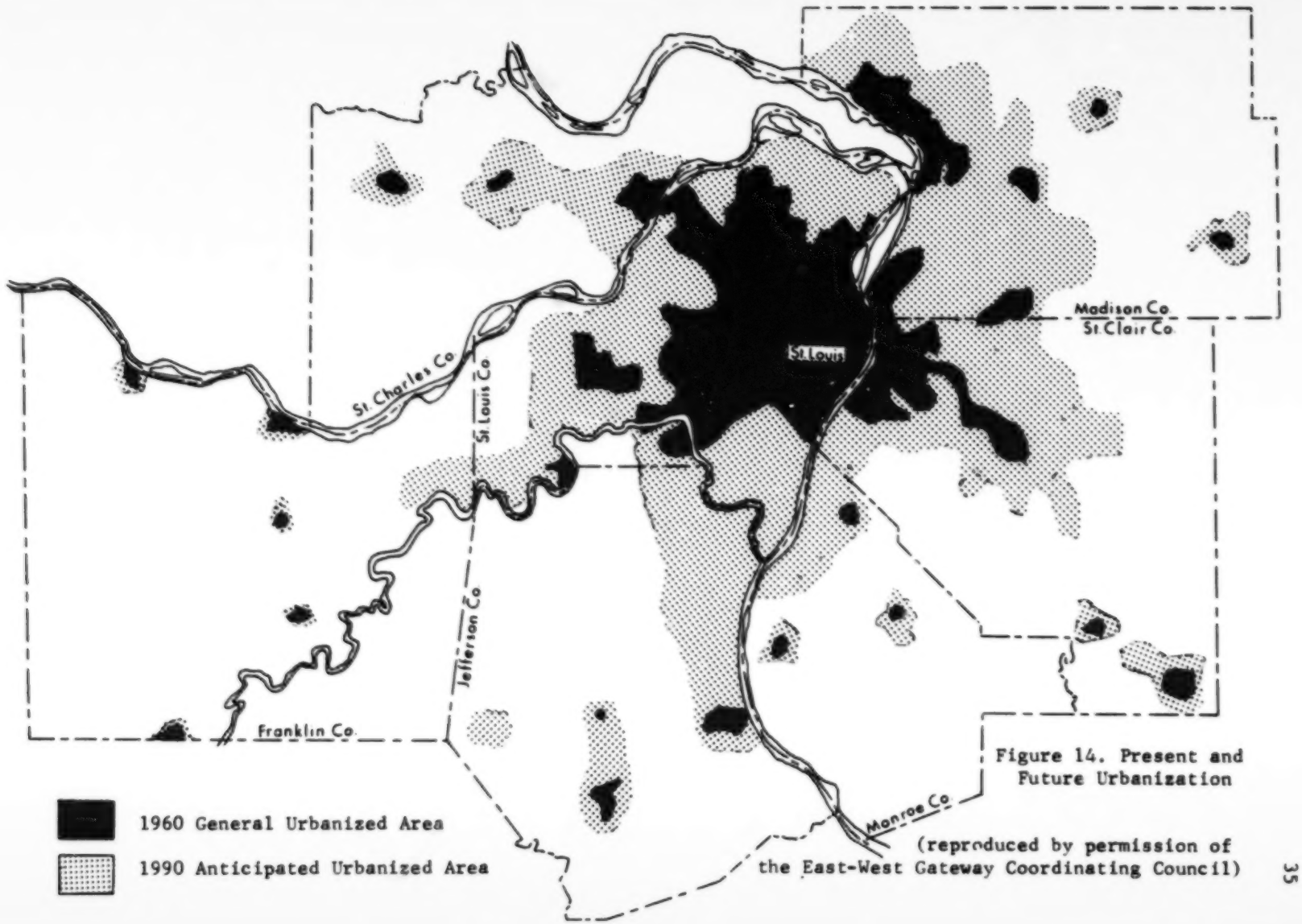


Figure 14. Present and Future Urbanization

(reproduced by permission of the East-West Gateway Coordinating Council)

Jefferson, and Monroe Counties is, at present, noncontiguous with the central core area. The possibility, therefore, that by 1990 parts of these counties may become engulfed by the expanding St. Louis metropolitan complex is significant.*

The 1960 population density in the St. Louis metropolitan area is shown in Figure 15.[2] Table II shows population growth by jurisdiction from 1960 to 1990 by five-year increments.[1] In 1960, St. Louis City had a higher population than any of the surrounding counties. But, as Table II points out, St. Louis City population has begun to decrease as the populace leaves the inner city to the surrounding counties. St. Louis County is and will remain the highest populated jurisdiction in the area.

The rank of each jurisdiction based on present and future population and expected population growth is presented in Table III. Based on absolute growth, the counties of St. Louis, Jefferson, and Madison, respectively, will be the fastest growing areas. By percentage rate of growth, however, Jefferson, St. Charles, and Monroe, respectively, will experience the most rapid growth.

Industry

Figure 16[3]** shows present industrial land use in the core of the Metropolitan St. Louis Area. Industry is dense in St. Louis City

*The 1990 urbanization pattern is based on present random growth trends and reflects neither a desired urban form endorsed by the East-West Gateway Coordinating Council nor county-wide zoning.
**Redrawn and produced in this report by permission of the East-West Gateway Coordinating Council.

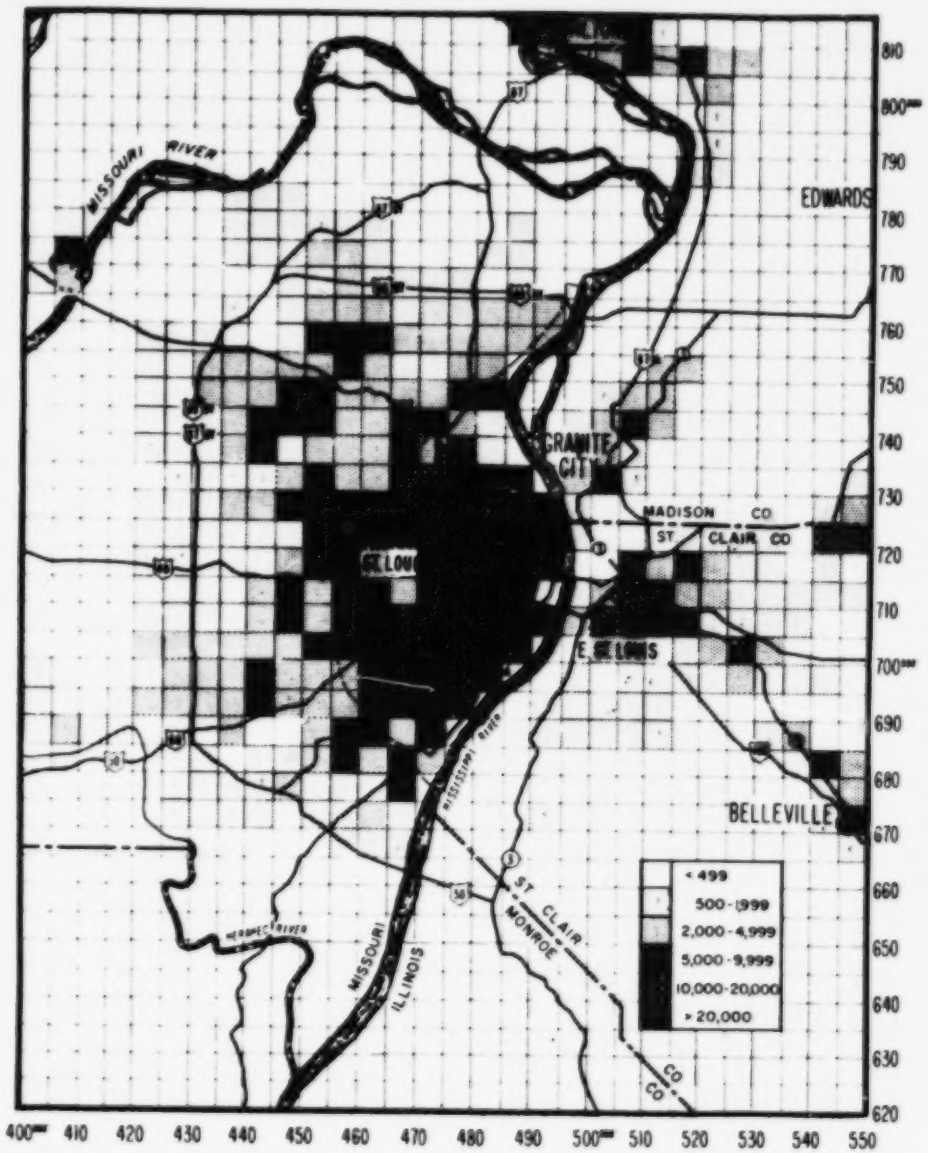


Figure 15. Population from 1960 census by 5,000-foot grid squares.

TABLE II.*[1] POPULATION PROJECTIONS FOR ST. LOUIS METROPOLITAN AREA

Jurisdiction	Population							Population Change 1960-1990	% Change 1960-1990
	1960	1965	1970	1975	1980	1985	1990		
St. Louis City	750,000	707,100	668,700	63,700	614,300	603,400	600,200	-149,800	-20%
St. Louis Co.	703,500	869,300	1,055,000	1,275,100	1,370,400	1,456,700	1,525,500	+822,000	+117%
Jefferson Co.	66,400	89,800	120,200	159,400	210,200	276,600	362,200	+295,800	+445%
St. Charles Co.	53,000	75,000	105,000	145,700	202,500	225,000	245,000	+192,000	+362%
Franklin Co.	44,600	49,900	55,200	70,700	91,[illegible]	[illegible],800	111,100	+66,400	+149%
Madison Co.	224,700	248,400	276,800	308,900	344,800	383,200	422,300	+197,600	+88%
St. Clair Co.	262,500	285,600	307,200	331,600	358,000	384,300	408,400	+145,90[illegible]	+56%
Monroe Co.	15,500	17,000	18,500	23,600	30,600	40,000	52,200	+36,700	+237%

*Figures from "Population Projections for the East-West Gateway Study Area," East-West Gateway Coordinating Council.

TABLE III. POPULATION RANKS OF MISSOURI AND ILLINOIS JURISDICTIONS IN THE ST. LOUIS METROPOLITAN AREA

	Jurisdiction	1965 Pop.	1990 Pop.	Growth 1960-1990 projected absolute	Growth 1960-1990 %
Missouri	St. Louis Co.	1	1	1	5
	St. Louis City	2	2	8	8
	St. Charles Co.	6	6	4	2
	Jefferson Co.	5	5	2	1
	Franklin Co.	7	7	6	4
Illinois	Madison Co.	4	3	3	6
	St. Clair Co.	3	4	5	7
	Monroe Co.	8	8	7	3

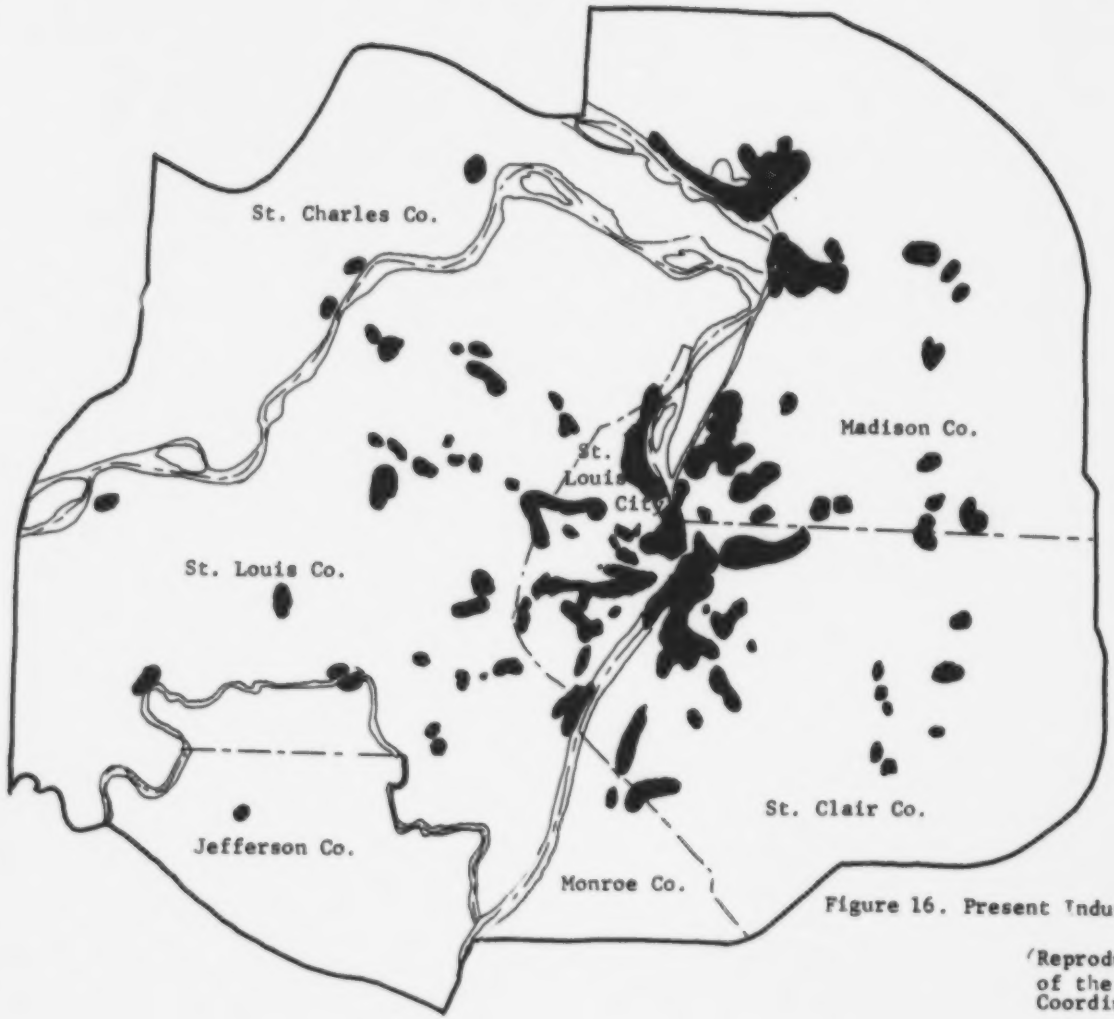


Figure 16. Present Industrial Land Use[3]

(Reproduced by permission of the East-West Gateway Coordinating Council)

and in portions of Madison and St. Clair Counties. St. Louis County, too, shows extensive industrial activity but is less concentrated than in the aforementioned jurisdictions. Figure 16 shows some industry in Monroe, St. Charles and Jefferson Counties.

Franklin County and most of Jefferson and Monroe Counties are not shown in Figure 16. Coal deposits in Monroe County indicate a potential for some industrial growth in the future. A power plant is being built in Monroe County and a new bridge at Harrisonville is planned. These plus the Kaskaskia River project indicate industrial and commercial growth in the future. Jefferson County at present has two large industrial concerns located near the Mississippi River. Plans for two new bridges and the completion of Interstate 95 will improve accessibility. The rural environment of Franklin County is expected to remain for some time. A power plant is presently being built there, but no great industrial growth is predicted for Franklin County in the near future.

Regional Agencies

The East-West Gateway Coordinating Council serves the Metropolitan St. Louis Area as both a planning agency and as the St. Louis Council of Governments. The jurisdictions included in the Council are St. Louis City, the counties of St. Charles, St. Louis, Jefferson, and Franklin in Missouri, and the counties of Madison, St. Clair, and Monroe in Illinois. The primary functions of the Council include the following:[4] transportation planning, development of regional plans and programs, collection of data, review of proposals by governmental

units, and the fostering of metropolitan cooperation between local governments in the Metropolitan St. Louis Area.

The Southwestern Illinois Metropolitan Area Planning Commission handles planning efforts on the Illinois side of the Metropolitan Area. The Commission deals with transportation, land-use, and other planning programs for its three county jurisdiction comprised of Madison, St. Clair, and Monroe Counties. These efforts are then coordinated with the East-West Gateway Coordinating Council.

Existing Air Pollution Programs

Four air pollution control agencies have authority to control air pollution problems in the Metropolitan St. Louis Area. In Missouri, the Missouri Air Conservation Commission, formed under the Missouri Air Conservation Law, has state-wide jurisdiction for administering air pollution control. The Commission may designate a certificate of exemption to a local agency when the agency adopts regulations at least as stringent as those set by the Commission. The Commission has issued such certificates to St. Louis City and to St. Louis County. In Illinois, control of air pollution is vested in the Air Pollution Control Board by virtue of the Illinois Air Pollution Control Act. The Illinois Board was also given the authority under the Act to award certificates of exemption to effective local agencies. To date, no certificates have been issued to air pollution programs in the Illinois portion of the Metropolitan St. Louis Area.

The Missouri Air Conservation Commission has adopted regulations

and standards for Jefferson, St. Louis, and St. Charles Counties, and St. Louis City. These standards became effective on March 24, 1967, and pertain to open burning, SO_2 and particulate emissions, coal washing, control of odors, etc.

Regional cooperation is fostered by the Air Pollution Technical Coordinating Committee for the St. Louis Area (APTCC). This Committee, formed in early 1968, is composed of officials from the State of Illinois, the City of St. Louis, St. Louis County, and the State of Missouri. In the rules adopted April 9, 1968, the purpose of the Committee was outlined:

> "To strive for compatability and uniformity in the technical management of air pollution control among the four political entities (States of Illinois and Missouri, St. Louis City and St. Louis County); to designate appropriate staff or services to eliminate or reduce duplication of effort among the four agencies; to provide a means for sharing and evaluating surveillance, emission, and other associated data necessary to conduct program operations; and to provide a forum for exchange of useful information."

REFERENCES

1. "Population Projections for the East-West Gateway Study Area," prepared by Hubert Williams, East-West Gateway Coordinating Council, September 3, 1968.

2. "Interstate Air Pollution Study," Phase II Project Report, Volume I, Introduction, N.C. Edmisten, J.W. Sadler, F. Partee, and J.D. Williams, USDHEW, PHS, Cincinnati, Ohio, May, 1966.

3. "Industrial Land Use," April 30, 1968, Exhibit No. 7, East-West Gateway Coordinating Council.

4. "East-West Gateway Coordinating Council Report, 1968."

5. "An Inventory and Analysis of Existing Data, Characteristics and Facilities in the Illinois Portion of the St. Louis Metropolitan Area," Volume IV, Southwestern Illinois Metropolitan Area Planning Commission, Collinsville, Illinois, December, 1965.

6. "Air Quality Standards and Air Pollution Control Regulations for the St. Louis Metropolitan Area," eff. date, March 24, 1967, Missouri Air Conservation Commission, Jefferson City, Missouri.

THE PROPOSED REGION

Subject to the scheduled consultation, the Secretary, Department of Health, Education, and Welfare, proposes to designate an air quality control region for the St. Louis metropolitan area, consisting of the following jurisdictions:

In the State of Illinois

Madison County

St. Clair County

Monroe County

In the State of Missouri

St. Louis City

St. Louis County

St. Charles County

Jefferson County

As so proposed, the Metropolitan St. Louis Interstate Air Quality Control Region would consist of the territorial area encompassed by the outermost boundaries of the above counties. The proposed region is illustrated in Figure 17. Figure 18 locates the region in relation to the rest of Missouri and Illinois and surrounding states.

Discussion of Proposal

To be successful, an air quality control region should meet three basic conditions. First, its boundaries should encompass most pollution sources as well as most people and property affected by

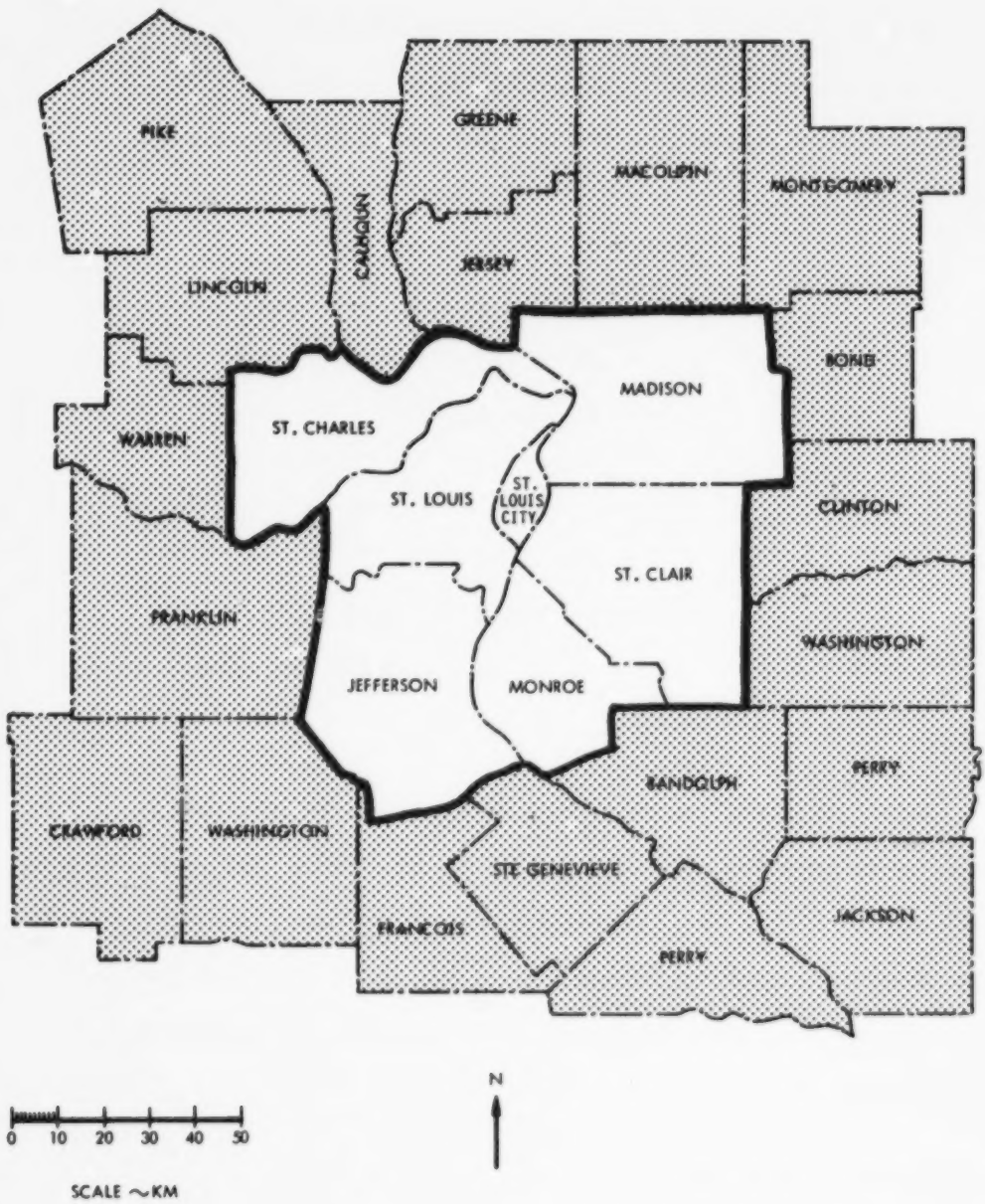


Figure 17. Proposed Metropolitan St. Louis Interstate Air Quality Control Region

Figure 18. Relationship of Proposed Metropolitan St. Louis Interstate Air Quality Control Region to surrounding areas.

those sources. Second, the boundaries should encompass those locations where industrial and residential development will create significant air pollution problems in the future. Third, the boundaries should be chosen in a way which is compatible with and even fosters unified and cooperative governmental administration of the air resources throughout the region. The "Evaluation of Engineering Factors" (discussion beginning with Page 12) discussed the first of these conditions, and the "Evaluation of Urban Factors" (Page 34), the second and third.

The core area of an urban complex with respect to the engineering and urban factors can usually be defined with ease. The core area usually has the maximum population density, maximum pollutant emissions, and maximum pollution concentrations. No exact boundary can be drawn around the core, but figures 4, 5, 6, 9, 10, 13, 14, 15, and 16 illustrate that the approximate area is comprised of St. Louis City, eastern St. Louis County, northwestern St. Clair County (East St. Louis) and south-western and western Madison County. Since this area represents the core of the metropolitan area, clearly it should be included in the Metropolitan St. Louis Air Quality Control Region.

Inclusion of whole county jurisdictions as implied by the Air Quality Act of 1967 should be considered when feasible. Exceptions to this rule have been made in previous region designations for three reasons: first, in some areas of the United States, counties are not utilized as administrative units (especially New England); second, topographical features such as a mountain range cutting through a county affect the meteorology in the jurisdiction,

producing, in effect, more than one "air shed"; and third, the size of some counties has obviated the desirability of including the whole county.* These exceptions are not the rule in the St. Louis area, so whole counties which have portions in the core area are recommended for inclusion in the Region.

A region, however, should provide ample area for expansion, both industrial and residential. A buffer zone should circumscribe the core area so that the region boundary need not be altered in the near future. This peripheral area would also include more people and property subjected to adverse air quality levels caused from emissions in the core area.

The northern tip of Monroe County lies less than five miles from the city limits of St. Louis City. Though sparsely populated at present, its proximity to St. Louis provides an ideal direction for expansion from the St. Louis area. It is anticipated that Monroe County will be included in the SMSA** following the 1970 census. Diffusion model analysis and air sampling data (from St. Louis City and County) indicate that the northern part of Monroe County is affected by above-background levels of particulates and adverse levels of SO_X.

Jefferson County, like Monroe County, provides a buffer for expansion to the south of St. Louis City. Percentage rate of

---

* For example, Arapahoe and Adams Counties in the Denver AQCR are both approximately 70 miles long (East-West) with urbanization and growth prospects only in the western 10-15 miles of the counties.

** Standard Metropolitan Statistical Area as defined by the Bureau of the Census.

population growth in the next 30 years is anticipated to be the greatest of all jurisdictions in the metropolitan area. Adverse air quality levels caused by emissions from the core area are prevalent in the north-east corner of the county. And, two major point sources close to the Mississippi River add to the air pollution problem.

Parts of St. Charles County are very definitely affected by pollution emissions in Madison County. All three pollutants discussed in this report show adverse levels in eastern St. Charles County. This, coupled with its projected population figures (expected to be the 2nd most rapidly growing area by per cent in the metropolitan area) indicate a potential problem area which should be included in the Air Quality Control Region.

The last county in the Study Area, Franklin, and the two other counties mentioned in this report, Jersey and Macoupin, are not recommended for inclusion at the present time. Franklin, though part of the SMSA and the East-West Gateway Coordinating Council, has and will retain its rural character in the near future. Its distance from St. Louis City makes commuting time a disadvantage. It is not included in the Missouri Air Conservation Commission's St. Louis Metropolitan Area which has adopted regulations and standards for Jefferson, St. Louis, and St. Charles Counties and St. Louis City; and, at present, it is not adversely affected by emissions from the core area. However, close observation

for possible inclusion at a later date should be made on Franklin County as it develops in the future.

Both Jersey and Macoupin Counties in Illinois do not contribute to the problem but are affected by emissions in the east St. Charles-west Madison County area. These two counties are not at present, nor expected to become in the near future, an integral part of the St. Louis Metropolitan complex.

As is true of most efforts to draw boundaries around an area to differentiate it from its surroundings, there is always a likelihood of boundary conditions existing or developing. In the case of Air Quality Control Regions, such a boundary condition would exist where sources of pollution on one side of the region boundary affect in some real way air quality on the other side of the boundary. Relocating the boundary would only rarely provide relief from this condition. The solution is to be found in the way in which control efforts are implemented following the designation of an Air Quality Control Region. Consonant with the basic objective of providing desirable air quality within the problem area being designated as an Air Quality Control Region, the implementation plan that follows the designation should have provisions for the control of sources located close to but beyond the region boundaries. The level of control for such sources would be a function of, among other factors, the degree to which emissions from sources cause air quality levels to exceed the standards chosen for application within the Air Quality Control Region.

In summary, the Region proposed is considered on the whole to be

the most cohesive and yet inclusive area within which an effective regional effort can be mounted to prevent and control air pollution in the two-state urban area surrounding St. Louis.

APPENDIX A. EMISSION INVENTORY

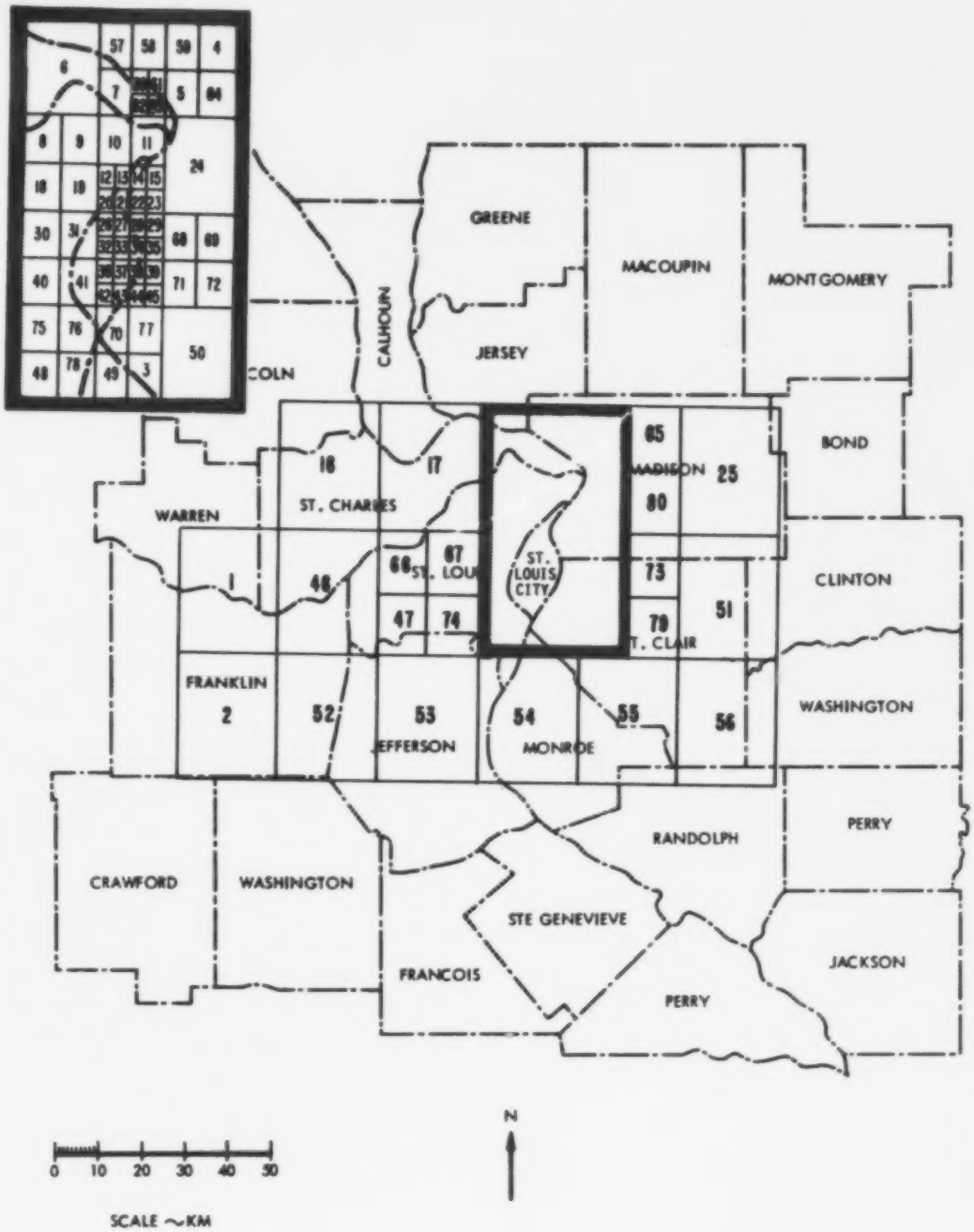


Figure A-1. Sulfur Oxides and Particulate Emission Inventory Zones

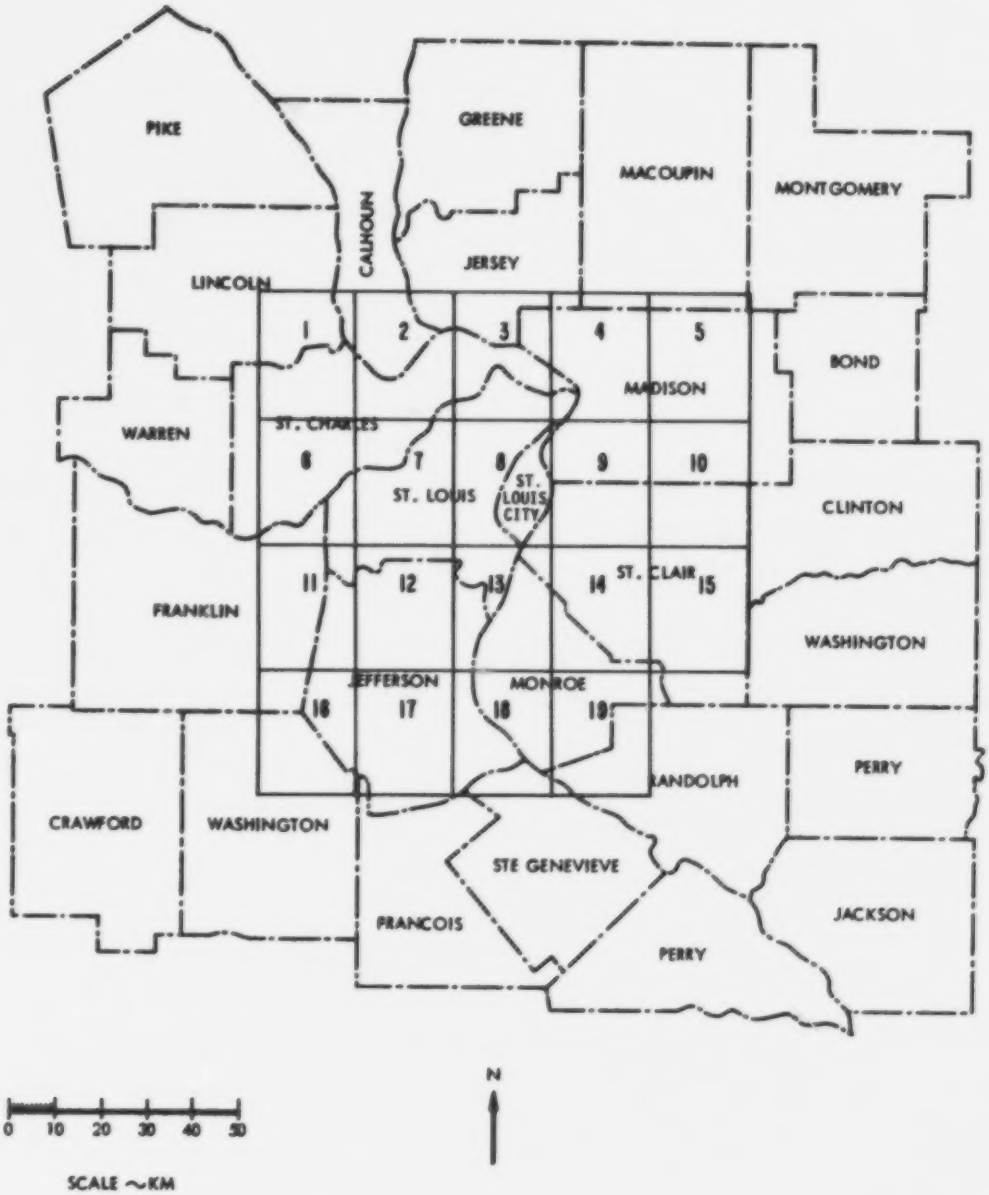


Figure A-2. Carbon Monoxide Emission Inventory Zones

Table A-1

Summary of SO_x and Particulate Emissions from Area Sources, Ton/Day

Grid	Area Sq.Km.	SO_x			Particulate		
		S	W	A	S	W	A
1	707.4	.01	.01	.01	.04	.04	.04
2	707.4	.01	.01	.01	.04	.04	.04
3	44.2	.01	.60	.27	.03	.27	.13
4	44.2	.03	2.88	1.28	.08	1.17	.50
5	44.2	.43	5.58	2.80	.47	2.61	1.41
6	176.8	.03	.33	.21	.16	.31	.23
7	44.2	.02	.47	.18	.17	.33	.24
8	44.2	.04	1.03	.48	.05	.42	.21
9	44.2	.46	1.22	.77	.20	1.03	.23
10	44.2	.01	.45	.20	.06	.21	.13
11	44.2	.02	.46	.21	.04	.19	.10
12	11.1	.01	.51	.23	.03	.24	.13
13	11.1	.03	.28	.14	.04	.14	.09
14	11.1	.01	.14	.07	.10	.15	.12
15	11.1	.01	.01	.01	.07	.07	.07
16	707.4	.03	.96	.44	.13	.49	.28
17	707.4	.09	1.87	.88	1.39	2.02	1.67
18	44.2	.05	5.07	2.29	.49	2.47	1.38
19	44.2	.06	2.94	1.12	.05	1.09	.52
20	11.1	.05	2.27	1.43	.18	1.06	.73
21	11.1	.55	1.05	.77	.38	.57	.46
22	11.1	.01	.68	.67	.07	.33	.33

(Continuation of Table A-1)

Grid	Area Sq.Km.	SO_x			Particulate		
		S	W	A	S	W	A
23	11.1	.24	3.74	1.78	.40	1.87	1.02
24	176.8	.03	1.91	.85	.15	.88	.48
25	707.4	.02	2.42	1.07	.07	1.01	.49
26	11.1	1.04	7.04	3.74	2.50	4.47	3.38
27	11.1	.22	2.56	1.17	.50	1.72	.84
28	11.1	.03	2.70	1.21	.50	1.57	.97
29	11.1	.96	5.60	3.00	2.20	4.03	3.02
30	77.2	.35	5.99	2.82	1.08	3.35	2.11
31	44.2	.18	42.56	19.28	.17	17.2	7.68
32	11.1	.07	26.32	11.61	.17	10.73	4.83
33	11.1	1.18	16.96	6.95	.56	6.41	3.15
34	11.1	.43	8.60	4.35	2.20	5.30	3.75
35	11.1	.44	1.70	.86	2.18	2.56	2.35
36	11.1	.29	19.20	8.66	.74	7.76	3.84
37	11.1	.08	13.58	6.02	.27	5.69	2.66
38	11.1	.03	6.17	2.76	.18	2.43	1.20
39	11.1	.01	5.12	2.26	.07	2.10	.96
40	44.2	.08	5.48	2.89	.40	2.59	1.97
41	44.2	.11	11.92	5.31	2.72	7.46	4.90
42	11.1	.76	6.14	2.83	.19	2.30	1.16
43	11.1	.05	11.65	5.15	1.05	5.57	3.05
44	11.1	.13	2.60	1.21	.24	1.23	.67
45	11.1	.02	.50	.23	.07	.25	.15
46	707.4	.06	3.19	1.90	3.46	1.88	1.85

(Continuation of Table A-1)

Grid	Area Sq.Km.	SO_x			Particulate		
		S	W	A	S	W	A
47	176.8	.15	1.13	.58	1.09	1.44	.34
48	44.2	.05	1.02	.48	.16	.50	.18
49	44.2	.01	.30	.14	.05	.16	.11
50	176.8	.03	4.96	2.20	.33	2.26	.89
51	707.4	.03	3.22	1.43	.07	1.28	.65
52	707.4	.12	3.05	1.41	.11	1.18	.69
53	707.7	.07	2.32	1.16	.20	1.01	.58
54	707.4	.05	2.22	1.00	.22	1.06	.39
55	707.4	.01	.91	.43	.02	.40	.24
56	707.4	.03	1.54	.70	.07	.61	.24
57	44.2	.00	.11	.05	.00	.04	.15
58	44.2	.01	.91	.41	.07	.43	.24
59	44.2	.02	3.03	1.34	.08	1.27	.69
60	11.1	.01	1.34	.68	.14	1.66	.80
61	11.1	.09	1.89	.88	.58	1.29	.28
62	11.1	.01	.27	.13	.05	.14	.07
63	11.1	.02	.20	.09	.03	.19	.22
64	44.2	.04	3.72	1.66	.19	1.65	.80
65	176.8	.02	.71	.32	.14	.41	.17
66	176.8	.02	1.10	.42	.03	.44	.22
67	176.8	.06	1.85	.84	.04	.63	.57
68	44.2	.05	12.71	5.62	.30	5.36	2.49
69	44.2	.31	3.82	1.57	.12	1.50	2.90
70	44.2	.07	7.01	3.12	1.11	4.91	7.58

(Continuation of Table A-1)

Grid	Area Sq.Km.	SO_x			Particulate		
		S	W	A	S	W	A
71	44.2	.11	18.34	8.12	.30	7.55	3.43
72	44.2	.01	1.10	.49	.07	.49	.26
73	176.8	.03	5.06	2.24	.07	2.04	.92
74	176.8	.04	1.36	.62	.10	.55	.26
75	44.2	.02	.97	.44	.04	.36	.12
76	44.2	.07	.87	.43	.12	.42	.37
77	44.2	.01	.76	.33	.07	1.94	.68
78	44.2	.02	.77	.35	.07	.31	.16
79	176.8	1.23	10.29	5.21	.57	4.16	2.09
80	176.8	.03	3.05	1.36	.15	1.34	.53

Table A-2

Summary of SO_x and Particulate Emissions from Point Sources, Ton/Day

Grid	SO_x			Particulate		
	S	W	A	S	W	A
5	15.57	15.57	15.57	7.06	7.06	7.06
5	9.84	9.84	9.84	1.09	1.09	1.09
5	60.76	60.76	60.76	5.51	5.51	5.51
7	0	0	0	19.18	19.18	19.18
7	0	0	0	8.22	8.22	8.22
13	0	0	0	2.79	2.79	2.79
17	0	0	0	3.04	3.04	3.04
24	18.79	18.79	18.79	10.80	10.80	10.80
23	5.14	5.14	5.14	7.98	7.98	7.98
24	1.46	1.46	1.46	.15	.15	.15
24	0	0	0	2.98	2.98	2.98
25	3.59	3.59	3.59	4.58	4.58	4.58
27	1.91	3.01	2.38	.61	.96	.76
21	1.28	2.02	1.6	.98	1.54	1.22
28	0	0	0	2.28	1.66	2.28
28	.30	.30	.30	2.55	2.55	2.55
29	6.19	6.19	6.19	.59	.59	.59
29	6.02	6.02	6.02	.56	.56	.56
32	0	7.65	3.29	0	6.84	2.94
26	0	3.90	1.68	0	.50	.21
33	1.84	2.9	2.30	1.64	2.60	2.05
70	6.25	9.88	7.82	4.77	7.56	5.99

(Continuation of Table A-2)

Grid	SO_x			Particulate		
	S	W	A	S	W	A
34	116.8	116.8	116.8	14.91	14.91	14.91
34	0	0	0	2.04	1.49	2.04
35	11.56	11.56	11.56	9.05	9.05	9.05
35	0	0	0	8.0	8.0	8.0
37	0	0	0	2.48	1.81	2.48
34	23.15	78.99	38.89	2.95	10.07	4.98
38	31.7	41.5	31.9	4.02	5.26	4.05
38	11.0	11.0	11.0	.17	.17	.17
38	0	0	0	2.48	1.81	2.48
39	4.99	7.90	6.95	6.96	10.44	8.70
39	0	0	0	3.5	3.5	3.5
41	0	7.32	3.15	0	9.34	4.02
41	1.09	1.71	1.35	1.39	2.19	1.73
36	4.87	7.69	6.08	4.35	6.87	5.44
37	0	5.17	2.22	0	6.60	2.84
43	1.26	1.99	1.58	1.61	2.54	2.01
43	14.3	22.6	17.9	1.83	2.89	2.29
34	21.4	33.8	26.7	4.09	6.47	5.12
43	.30	.30	.30	2.55	2.55	2.55
43	0	0	0	4.96	3.62	4.96
43	0	0	0	1.49	1.09	1.49
44	2.12	2.12	2.12	4.26	4.26	4.26
44	50.8	50.8	50.8	19.8	19.8	19.8
45	19.9	19.9	19.9	.32	.32	.32
74	0	0	0	2.4	2.4	2.4

(Continuation of Table A-2)

Grid	SO_x			Particulate		
	S	W	A	S	W	A
74	0	0	0	1.95	1.95	1.95
79	3.17	3.17	3.17	4.0	4.0	4.0
54	419.0	382.4	377.2	13.4	12.2	12.04
54	0	0	0	21.9	21.9	21.9
6	192.08	192.08	192.08	1.97	1.97	1.97
60	0	0	0	3.48	2.54	3.48
61	1.63	1.63	1.63	2.04	2.04	2.04
61	187.5	353.1	248.8	71.82	135.2	95.3
68	12.0	12.0	12.0	1.90	1.90	1.90
32	0	0	0	3.78	2.76	3.78
68	16.5	19.9	18.0	7.44	11.7	9.27
76	44.0	44.0	44.0	4.09	4.09	4.09
76	0	0	0	5.80	5.80	5.80
38	2.11	3.33	2.63	1.89	2.98	2.36
76	0	0	0	13.70	13.70	13.70
26	4.53	7.16	5.66	.86	1.36	1.08
74	0	11.03	4.74	0	14.04	6.05
18	3.70	3.70	3.70	.71	.71	.71
76	0	5.80	2.50	0	7.40	3.19
54	2.93	2.93	2.93	.37	.37	.37
54	0	0	0	5.98	5.98	5.98
53	0	3.29	1.42	0	.63	.27
54	232.3	232.3	232.3	0	0	0

Table A-3

Summary of CO Emissions from Point and Area Sources, Ton/Day

Grid	Area Sq.Km	CO S	CO W	CO A
4	Point	206.1	206.1	206.1
4	Point	522.1	522.1	522.1
4	Point	82.4	82.4	82.4
4	Point	.82	1.55	1.09
8	Point	3.08	3.08	3.08
9	Point	89.3	89.3	89.3
13	Point	1.84	1.68	1.65
1	621.38	18.55	19.46	18.95
2	621.38	18.68	20.04	19.26
3	621.38	62.97	69.13	65.61
4	621.38	163.65	179.5	170.44
5	621.38	18.19	19.60	18.80
6	621.38	19.50	21.37	20.30
7	621.38	108.82	111.09	109.85
8	621.38	2407.3	2481.3	2438.99
9	621.38	362.0	389.25	373.67
10	621.38	36.34	36.99	36.62
11	621.38	2.98	4.26	3.53
12	621.38	116.39	118.21	117.17
13	621.38	97.48	103.92	100.24
14	621.38	25.07	28.51	26.54

(Continuation of Table A-3)

Grid	Area (Sq KM)	CO		
		S	W	A
15	621.38	9.21	10.50	9.76
16	621.38	1.61	2.33	1.92
17	621.38	9.03	9.99	9.44
18	621.38	8.79	11.13	9.79
19	621.38	1.24	1.76	1.46

APPENDIX B. DIFFUSION MODEL DESCRIPTION

Title I, Section 107 (a) (2) of the Air Quality Act of 1967 (Public Law 90-148, dated November 21, 1967), calls for the designation of air quality control regions, based on a number of factors, including "atmospheric conditions," interpreted to mean that the boundaries of air quality control regions should reflect the technical aspects of air pollution and its dispersion. Within this guideline, however, the position has been taken that region boundaries cannot be based on an extreme set of circumstances which might have a theoretical chance of occurrence. Hence, the analysis of a region's atmospheric dilution is largely based on mean annual values, although summer and winter mean values are analyzed with respect to reviewing seasonal variations in meteorology and pollutant emissions.

With the realization that the meteorological analysis would help define tentative boundaries only and that final boundaries would be developed subsequently to reflect local government aspects, it was decided that the meteorological assessment should be as unpretentious as possible. Accordingly, the widely accepted long-term Gaussian diffusion equation, described by Pasquill[1] and Turner[2], has been applied with a few modifications to accommodate certain requirements inherent to the delineation of air quality control regions. In summary, the Gaussian diffusion equation is utilized to provide a theoretical estimate of the geographical distribution of long-period mean ground-level concentrations of SO_x, CO and suspended particulates. The model used has the necessary flexibility to utilize information on emissions from both point and area-wide sources.

To maintain simplicity, a 75 meter effective height for all point sources and a 3 hour half-life for SO_x were assumed.

METHODOLOGY

The diffusion model used is based on the Gaussian diffusion equation[1,2], as modified by Martin[3]. Essentially, the model sums the effects (ground-level concentration) of a number of sources (area and point) for a specified number of receptors, averaged over a season or a year. For this study, 225 receptor points were used. Their location was defined by an orthogonal grid system with mesh points 15 kilometers apart.

The meteorological data input to the model is screened to determine the representativeness of the data. Appropriate surface wind rose data are selected from U.S. Weather Bureau records; if necessary, special wind data tabulations are obtained from the National Weather Records Center (NWRC). The mean mixing depth for each region, for each respective time period (seasonal and average), is determined on the basis of computed mixing depths documented by Holzworth[4,5], and recent tabulations furnished the Meteorology Program by the National Weather Records Center (ESSA). Table B-1 gives the mixing depth values utilized by the model for computing theoretical ground level concentrations in the St. Louis area.

Table B-1

Average Mixing Depths for the St Louis Area by Season

Season	Mixing Depth, Meters		
	Morning	Afternoon	Average*
Summer	294	1689	992
Winter	390	797	594
Annual**	352	1340	846

*of morning and afternoon

**of all four seasons

References for Appendix B

1. Pasquill, F., "The Estimation of the Dispersion of Windborn Material," Meteorology Magazine, 90, 1963, pp. 33-49.

2. Turner, D. B., "Workbook of Atmospheric Dispersion Estimates," USDHEW, Cincinnati, Ohio, 1967.

3. Martin, D. O., and Tikvart, J. A., "General Atmospheric Diffusion Model for Estimating the Effects on Air Quality of One or More Sources," Paper No. 68-148, 61st Annual Meeting, APCA, St. Paul, Minnesota, June 1968

4. Holzworth, G. C., "Mixing Depths, Wind Speeds and Air Pollution Potential for Selected Locations in the United States," J. Appl. Meteor., No. 6, December, 1967, pp. 1039-1044.

5. Holzworth, G. C., "Estimates of Mean Maximum Mixing Depths in the Contiguous United States," Mon. Weather Rev. 92, No. 5, May 1964, pp. 235-242.

• U.S. GOVERNMENT PRINTING OFFICE : 1968 314-860 (5003)